

SCHOOL SCIENCE AND MATHEMATICS

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WHOLE No. 331

A PROGRAM IN THE MAKING

The plan of the program for the convention of the Central Association of Science and Mathematics Teachers at Chicago on November 25th and 26th was described in the April number of this Journal. The general and sectional officers made a careful survey of the best available talent to carry this program into action. The following list of speakers illustrates the rapid progress being made in completing the plans as made. The speakers listed below have accepted invitations to appear, others have tentatively accepted the invitations extended to them. Further acceptances will appear in the June number.

For the general meetings:

Dr. Morris Meister, Director of Science in the Junior High Schools of New York City.

Dr. W. W. Bauer, Director of the Bureau of Health and Public Instruction of the American Medical Association.

Earl A. Taylor, Research Specialist in Reading, American Optical Company.

Dr. J. S. Georges, Professor of Mathematics, Wright Junior College, Chicago.

Biology Section—Lillian Bondurant, Chairman.

C. E. Godshalk, Superintendent of the Morton Arboretum.

L. N. Silverman, President of the American Breeders Association.

Chemistry Section—R. E. Whitney, Chairman.

Professor B. S. Hopkins, University of Illinois.

M. C. Crew, Austin High School, Chicago.

H. R. Smith, Lakeview High School, Chicago.

Elementary Science Section—D. W. Russell, Chairman
Dr. W. W. Croxton, State Teachers College, St. Cloud,
Minnesota

Miss Mary Melrose, Supervisor of Elementary Science,
Cleveland

Miss Veva McAtee, Supervisor of Science, Hammond, Indiana

Professor Clara Belle Baker, National College of Education,
Evanston

Professor Louis M. Heil, Ohio State University

Ralph B. Jones, Principal, Peabody School, Fort Smith,
Arkansas

General Science Section—Theodore J. Kuemmerlein, Chairman

Rosalind M. Zapf, Cleveland Intermediate School, Detroit

Harold Stamm, West Allis (Wisconsin) High School

L. H. Fuller, Boys Technical High School, Milwaukee

Geography Section—Helen S. Turner, Chairman

Dr. Edwin H. Reeder, Professor of Education, University of
Illinois

Miss Clare Symonds, Senior High School, Quincy, Illinois

Mrs. R. W. Mikesell, Froebel School, Chicago

Mathematics Section—Prof. H. C. Christofferson, Miami University, President of the National Council of Teachers of Mathematics.

IRA C. DAVIS, *President*

HERBERT E. COBB

Professor Herbert E. Cobb, formerly of Chicago, but more recently of Searsmont, Maine, died Tuesday, March 1, at the Bradbury Memorial Hospital in Belfast, Maine, where he had been a patient for two weeks. He had been failing in health for some months.

He was born in Searsmont, July 4, 1860, the son of David B. and Mary C. Cobb. His earliest years were spent in that town, where he attended the public schools. He studied at Maine Wesleyan Seminary, Kent's Hill, from which he graduated in 1883. As a young man he taught in the public schools of his native town and surrounding towns. He attended Wesleyan

University, Middletown, Conn., receiving from that institution the Degree of A.B. in 1887, and that of A.M. in 1890.

He was teacher of mathematics at Maine Wesleyan Seminary during the years, 1887-90. On March 11, 1890 he married Miss Sara Maxson of Syracuse, N. Y., who was at that time the teacher of art at the Seminary. After leaving Kent's Hill, he served as instructor of mathematics at the University of Colorado, Boulder, for two years. Coming to Chicago in 1892, he taught in the extension division of the University of Chicago for the next four years, and also continued his study of mathematics at the same institution for much of that period. He became a teacher of mathematics at the Lewis Institute, Chicago, in 1896, serving in a subordinate position for ten years, and being head of the department of mathematics for twenty-six years. He studied at the University of Berlin in 1905-06.

Professor Cobb was a member of the American Mathematical Society, of the Society for Promotion of Engineering, and of the National Education Association. At Wesleyan University he was a member of the Alpha Delta Phi Fraternity, and at Lewis Institute a member of the Daedalian Fraternity. He was also a member of Phi Beta Kappa. He had served as Department Editor of SCHOOL SCIENCE AND MATHEMATICS, and was author of *Elements of Applied Mathematics*.

For many years Professor Cobb was active in the work of his church, serving as Treasurer of the Park Ave. M. E. Church in Chicago for some years, and later being identified with the Sacramento Boulevard M. E. Church of the same city. He was also interested in the temperance movement, and was for a time a director of the Washingtonian Home in Chicago.

After a brief illness in April, 1932 he resigned his position at Lewis Institute, returning to his native town to spend the remaining years of his life with his brother, Eben Cobb, at the home of the latter. He was a member of the Searsmont M. E. Church at the time of his death.

Professor Cobb was of a quiet, retiring nature, but was a thorough student, continuing his interest in the study of his favorite subject, mathematics; even during his years of retirement from teaching. He was a great reader. He was also fond of outdoor life, and engaged in fishing and gardening as long as his health and strength permitted.

He is survived by one brother, Eben Cobb of Searsmont; two

nieces, Mrs. Albert A Belyea of Virden Illinois, and Mrs. E. Bliss Marriner of Portsmouth, New Hampshire; two nephews, Harold P. Cobb of Searsmont, and Maurice E. Cobb of Portland, Maine; and by a number of grandnieces and grandnephews. Mrs. Cobb passed away in 1917.

Funeral services for Professor Cobb were held at the Coombs Undertaking Parlors in Belfast, Saturday P. M., March 5, with Rev. Gardner Wills, Pastor of the Searsmont M. E. Church, officiating. The body was placed in the receiving tomb in Grove Cemetery, Belfast, and interment will be in the family lot at Oak Grove Cemetery, Searsmont, the coming spring.

WALTER R. SMITH

WORRALLO WHITNEY

For many years the letters "W.W." and later the name W. Whitney signed to special articles contributed, to book reviews, and other items appearing in our *SCHOOL SCIENCE AND MATHEMATICS* magazine have been familiar symbols which have invariably stood for careful and reliable work of a well trained, experienced and conscientious scientist. These services will be greatly missed now because Mr. Worrallo Whitney died on March 10 at his home in Chicago at the advanced age of seventy-nine years.

After serving in the Chicago high schools since 1893, first at the Crane Manual Training High School, then at the Bowen High School and from 1913 until 1928 at the Hyde Park High School, he had enjoyed a pleasurable retirement for the past ten years. For twenty years he had been able to spend most enjoyably his vacation seasons on his small farm near Three Oaks, Michigan. It was a delight to all of his friends who could visit him there to observe his wizardry and note the satisfaction he was getting out of putting into practice his scientific understanding in regard to soil improvement for fruit and flower culture. He was very successful in the grafting of fruit trees and he was especially proud of the tree onto which he had grafted a scion cut from a tree brought from England to the Ohio farm home of his boyhood. His father before him, who came West from New England in 1834, was a teacher, surveyor, farmer and nurseryman.

Mr. Whitney was intimately associated with the early

worthies of the C.A.S.M.T. Messrs. Charles H. Smith, Charles M. Turton, James Smith and others. For many years his name has appeared on the title page of SCHOOL SCIENCE AND MATHEMATICS, which he served as Departmental Editor of Zoology 1911 to 1919 and of Botany from 1920 to 1938. He was one of the first teachers in Chicago to use the laboratory method in the teaching of zoology. Expertly trained in the sciences at Oberlin, Harvard and Johns Hopkins he was a valued guide to the Biology Round Table of Chicago. Collaborating with Walter and Lucas in 1900 he published *Studies of Animal Life*, and in 1911 he assisted Lucas, Shinn and Smallwood in the production of *A Guide for the Study of Animals*.

To all who ever knew Worrallo Whitney or had worked with him, associated either as scientist, fellow teacher or interested student, he will always be remembered most tenderly as the quiet gentle teacher, the kindly gardener and the humble servitor to all living things—to plants, to animals and to his friends and associates.

I. N. VAN HISE

**LAMME MEDAL OF ELECTRICAL ENGINEERS GOES
TO CARNEGIE INSTITUTE OF TECHNOLOGY'S
PRESIDENT**

Dr. Robert E. Doherty, president of Carnegie Institute of Technology, Pittsburgh, is to be the recipient of the 1937 Lamme Medal.

The medal, to be presented at the June convention of the Institute in Washington, D. C., has been granted for Dr. Doherty's "extension of the theory of alternating current machinery, his skill in introducing that theory into practice, and his encouragement of young men to aspire to excellence in this field."

The Lamme medal was founded by a bequest from the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company. Both a gold medal and a bronze replica are awarded.

**DUKE UNIVERSITY TO HAVE GRADUATE SCHOOL
OF FORESTRY**

A graduate school of forestry, the first of its kind in the South and the third in the United States, will be open for students next fall at Duke University. The other two are at Harvard and Yale universities.

No undergraduate courses will be given in the new school, and only candidates presenting bachelor's degrees, in suitable pre-forestry subjects, will be accepted. The course will lead to the degree Master of Forestry.

The Duke Forest, of nearly 5000 acres, is immediately adjacent to the university campus, and will serve as the principal schoolroom and laboratory. In addition, the university is developing a 300-acre arboretum in which 54 species of trees have already been planted.

AN AMERICAN PROVINCE—THE SAN LUIS VALLEY

BY ALFRED CROFTS AND EARL LORY
Adams State Teachers' College, Alamosa, Colo.

A direct air route between Chicago and Los Angeles would intersect another joining Puget Sound to Houston, in the south central part of Colorado, near the headwaters of the Rio Grande. The same area would be an ideal base for a water-level route into Old Mexico. On a flat projection of North America this region—known as the San Luis Valley—would seem des-



FIG. 1. The San Luis Valley. Drawing by J. B. Smith.

tined to become the crossroads of the continent: actually, it is half-developed, and unknown to the average American.

The Rio Grande watershed is almost unique among river-basins in that it has supported three independent cultures, none of which originated at its mouth. The middle section was occupied by Pueblo Indians about 1300 A. D.; Spaniards advancing from Chihuahua and Monterrey occupied the coastal basin by 1700; more than a century later Lieut. Zebulon Pike, penetrating the Rocky Mountain passes, arrived at the uppermost section, which has become an Anglo-Saxon province. Under an older regime, this San Luis Valley would have been administered, probably from Albuquerque, as a political unit. All of its geographical affinities are with the south, from which it is now separated by the New Mexico state line. No province could wish for more defensible boundaries: on the east of the valley lies the Sangre de Cristo range whose four peaks—Culebra, Blanca, Crestone, and Kit Carson—are among the highest in the Rockies; to the west are the San Juan Mountains and the Continental Divide; across the south the low, flat-capped San Luis Hills cut across the Rio Grande, forming the impassable Black Canyon.

WEATHER AND TOPOGRAPHY

The floor of the San Luis Valley has an altitude of 7500 feet; it is the highest large cultivated area in the United States. While its latitude is that of southern Virginia, its isotherm appears as an extended finger pointing from the Canadian border. Between Alamosa, Colo. and Las Cruces, N. M. the climates of Montreal and Atlanta approach within three hundred miles of each other. The center of the valley is the driest spot in Colorado, although the nearby San Juan peaks attract more moisture than any other part of the southern Rockies. The air is rarefied and clear; no "black blizzard" from the plains has ever crossed the Sangre de Cristo ridge; in fact, many northerly gales are split at the head of the valley, to pass harmlessly outside. Thus, the weather depends largely upon the rhythmical movement of air between valley and summits: until late spring, nightly frosts alternate with noon temperatures as high as eighty degrees. Altitude has no marked physiological effect upon healthy persons after they become acclimated.

Six counties, with a total area of 8000 square miles, occupy the watershed: Saguache, Mineral, Rio Grande, Alamosa, Cone-

jos, and Costilla. The valley floor has the shape of a human hand; the thumb, pointing west, gives the course of the main river, and the knuckles mark a low divide, north of which all streams flow into a sump—the San Luis Lakes—or are lost in the sand. There have been constant changes in the drainage system. Pike noted a continuous series of sloughs running north and south: the Closed Basin has thus been formed within a century. It is conjectured that the Rio Grande has wandered at some time over every part of the San Luis Valley, laying down everywhere layers of gravel and clay, and leaving its surface almost perfectly flat. The drag of the earth's motion has moved the bed westward, so that now it lies close to the San Juan foothills.



FIG. 2. San Luis Valley panorama. Left, Great San Dunes. Center, Sand Creek disappearing into the subsoil. Background, Crestone area of Sangre de Cristo Range, with Mosca Pass below shoulder. Abandoned mine roads lead into the country, which is otherwise inaccessible. Photograph by McKinney.

GEOLOGY

Perhaps fifty main canyons discharge into the San Luis Valley, their walls often beautifully colored and sculptured. At Wagon Wheel Gap are huge cliffs of reddish granite, between which the river flows; they are far inferior scenically to the grotesque Wheeler National Monument, a mass of wind-carved rock close to the Continental Divide. Of greatest note are the Sand Dunes, also a part of the National Park system. These are irregular masses of sand strewn for twenty miles in front of the Sangre de Cristo Mountains, and reaching a height of nearly a

thousand feet. Their geology is obscure: some experts believe them to mark the shore of an ancient lake; a more numerous group holds that they are wind blown deposits from the valley floor. But the sands are entirely dust-free, filled with quartz crystals, iron magnetite and even flour gold; such particles could hardly have been moved by the wind. Thus, a third theory assigns their origin to the weathering of strata in the "Santa Fe" sandstone reef formations. No well-equipped expedition has ever visited them. Meanwhile, legends gather about these wastes—and often the dunes, retreating, uncover bones and human artifacts. Lakes and grassland are reported to exist in the very center of the sandhills.

There is more general agreement about the structure of the mountains. In early ages two immense folded ranges—the western one capped with lava—faced each other across a deep trough. The latter was steadily filled with alluvial clay and gravel. Subsequent volcanic action threw up a dike transversely between the mountains and formed, still farther south, the twin, perfectly rounded knolls that today guard the entrance to the valley: Ute Peak and San Antonio Mountain. Deep drilling has not yet found the bottom of the gravel layers, but it never fails at a depth of a thousand feet to bring up hot water—the last trace of dying volcanic activity. Hot surface streams are found at Ojo Caliente, Wagon Wheel Gap, and Valley View; the Pagosa High School is heated entirely by hot water piped from thermal springs. Near Mosca inflammable gas rises in the artesian flow; thought by prospectors to be petroleum, it is now recognized as marsh gas exhaled by the buried vegetation of an ancient swamp.

EARLY HISTORY

With the glaciers geology passes into pre-history. The Great Ice Sheet never reached lower Colorado; there was, nevertheless, glaciation in all the canyons, which change abruptly in their lower level from an ice-carved U-shape to the conventional V-shape of a river valley. As the ice melted, the mysterious Folsom man was living in the caves; his crude spear-points are found frequently today. Perhaps contemporary with him the mammoth ranged over the saturated marshes; bones and teeth of this giant occur in the subsoil within five feet of the present ground level.

The first historical tribes to occupy the land were turquoise

miners, probably Aztecs, who left their stone ore-hammers in an abandoned shaft near the San Luis Hills. Much later, Pueblo peoples marched up the valley, and Kiowas and Utes crossed the passes each summer to hunt buffalo and elk, but they never remained to face the terrible high-altitude winters. They left

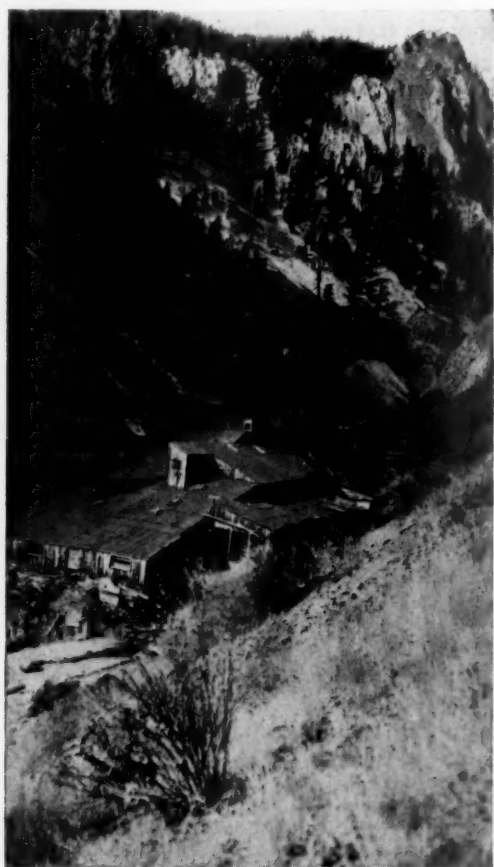


FIG. 3. Abandoned ore mill, on one of the richest mineral lodes in the United States, near Creede. The town, with a boom population of 10,000, has almost disappeared. Second growth timber covers many of the diggings. Photograph by McKinney.

behind them pottery fragments, pictographs in Costilla and Rock Creek canyons, and literally thousands of corn-grinding *metates*, as well as numberless arrow heads. Jesuit priests built a mission "forty leagues north of Santa Fe" to convert these nomads, but no trace of it remains; Spanish gold-seekers worked

several mines in the Sangre de Cristo area, leaving at least two *arastas* (primitive ore mills) near Trinchera Creek. After these pioneers came Lieut. Pike, looking for the sources of the Arkansas River; he built on the Conejos the first fixed American settlement in the Far West. General Fremont attempted to winter in what is now Saguache County, and was rescued by Kit Carson after losing one-third of his command. The area was about this time claimed by both Mexico and the Republic of Texas; only after it had become United States territory did the first settlers, from Taos, push north and found the settlement of San Luis which gave the valley its name. Trade routes soon sprang up, crossing the plains in various directions and centering at Del Norte, a town which for a while rivaled Denver in size; Mormon immigrants founded two "stakes" or colonies at Manassa and Sanford. To protect these interests, a strong cavalry force was established at Fort Garland.

The Denver & Rio Grande Railroad, coming to Alamosa after 1880 and ramifying over the whole valley, gave agriculture and ranching a firm start; but their orderly development was interrupted by many mining strikes. Gold was worked at Placer, Commodore, Liberty, and Crestone in the east range, but the mineral veins were badly fractured and soon worked out; the San Juan region was much more productive, Platoro, Summitville, and Bonanza yielding six million dollars between them. At last, in 1889, N. C. Creede patented a mining claim two miles from the North Fork of the Rio Grande; the location, named for him, attracted a huge gold rush, and became the site of a city of 10,000 people. During the next two decades the fabulous Amethyst and Holy Moses mines yielded \$43,000,000, two thirds of it in silver; in total output they compare favorably with any in United States history except the Comstock Lode.

THE WATER PROBLEM

The decline of Creede about 1910 ended the mining era; part of its boom population, augmented by land-hungry eastern immigrants, settled in the valley: the whole Mosca area was brought under the plough, and a steady march of settlers moved on to Rio Grande County, north of the main river. Water, the "liquid gold" of the West, far more valuable and lasting than the yellow metal, became the principal resource.

As much as forty feet of snow fall annually on the San Juan Divide, together with ten feet on the Sangre de Cristo. Half

of this melts into the Colorado and is impounded in Lake Mead above Boulder Dam; nearly a million acre feet of water annually flows past Wagon Wheel Gap into the San Luis Valley; but this supply is preempted—a century before the founding of San Luis, communities in New Mexico had acquired rights to the flow of the Rio Grande. It is no exaggeration to say that part of the wealth of Los Angeles, of the Indian Pueblos and the Texas citrus belt, is drawn without compensation from the summits of Rio Grande County.

San Luis Valley farmers now watch their water-supply flow past to consumers below them: the Federal Government has forbidden any storage north of Elephant Butte Dam on the main river. There are reservoirs on a few tributary streams that assure a fair water right to certain farmers; besides, two huge irrigation systems carry the spring surplus to valley fields at the cheapest rates in the West—fifty cents an acre foot. Unless the water supply can be kept regular and continuous it is of little use; tremendous demand, backed in Congress by Colorado's senators, has grown up for a dam at Wagon Wheel Gap. State engineers argue that such a dam would in no wise hurt the water supply of New Mexico, since almost all the irrigation used returns to the main channel by "sub-flow"; records sustain their view.

During a measured period,¹ 675,000 acre feet passed Del Norte, of which but 350,000 remained at Alamosa, thirty miles downstream; the loss was due in part to ditch diversion, but equally to seepage through exposed gravel beds. These beds, saturated with water, and separated from each other by impermeable clay, form the most remarkable artesian reservoir in the West. Over six thousand wells have been sunk into them, adding 142,000 acre feet to the water supply; though the land surface is everywhere arid, basement excavations near the river become, unless protected, standing pools. That this water eventually reaches the river is indicated by the fact that, in the period already mentioned, 725,000 feet poured across the state line—twice as much as at Alamosa even when the inflow of lower tributaries has been subtracted.

ECONOMIC DEVELOPMENT

Of five million acres in the six counties, one half is unappro-

¹ May 15 to Oct. 1, 1912. See *Water Supply Paper 358*, Washington 1915, pp. 75, 79, 97

priated government and state land, chiefly forest; one twentieth is classified as irrigated. Unless there are more water allotments, the population will remain close to its present figure of 40,000, six per square mile. Compared to other citizens of the United States these people are fairly fortunate: their "per capita wealth" is \$2500, under the Colorado average² but greater than that of any Southern state. There is no resident millionaire among them, and there are few paupers, yet county statistics show amazing discrepancies in living standards. Alamosa spends \$14.60 per capita on government, Saguache \$3.65; in the last census decade Alamosa showed the largest population increase among 62 counties in the state; Mineral suffered a large net loss. In total bank deposits the counties rank between tenth and sixty-first.

Population density is equal among the counties; the people are native-born, of Middle-Western origin. Close to the New Mexico border Spanish is the official language, most of the older generation cannot read or write English, and the public school system has been permitted to break down. Three of the northern counties average \$70 per pupil in operating cost; the border communities spend \$40: the corresponding figures for New York State are \$160. Yet an instructive contrast may be drawn between Conejos and Costilla Counties; though they are nearly identical in size and resources, separated only by the river, the former has almost twice the tax valuation and school investment, four times the number of livestock, and substantially larger bank deposits. Costilla is mainly Spanish-American; Conejos has 2500 thrifty Mormons; these Mormons have, incidentally, supplied the valley's two most famous names—Heber J. Grant³ and Jack Dempsey.

Social experimentation has gone on in the Rio Grande basin as elsewhere. The theocracy of Father Martinez at Taos resembled that of the Oneida Community or the House of David. San Luis was founded as a semi-communal society; each settler received a tract of farm land, but all public work and manufacture was done by joint effort. Though private enterprise is now dominant, the wide foothill pastures are still common property. Likewise, the Mormons in Manassa operated all retail business cooperatively for many years.

² By the rather loose calculation of the 1935 *World Almanack*, p. 539.

³ President of the Latter Day Saints' Church, a great industrialist and Director of the Union Pacific Railroad.

"RUGGED INDIVIDUALISM" IN THE ROCKIES

The United States should have formed at the time of the Mexican cession a state embracing the whole Rio Grande watershed above El Paso; instead, it divided the area at the thirty-seventh parallel. The San Luis Valley, cut off on both sides from the rest of Colorado, has never fully adhered to it; meanwhile, it is politically divorced from the culture to the south. To the blunders of Washington, it has added a major one of its own: the formation of six wastefully duplicating county governments where one, seated at Alamosa, would always have sufficed.



FIG. 4. Foothills near Cochetopa Pass. Mining developments have resulted in the almost complete destruction of the original spruce forest. A few young spruce are rising above the aspen cover on the burned-over slopes. Photograph by Wilhelm.

The story of its resources is that of the exploitation of America since 1850: it illustrates the optimism and the madness that go with "rugged individualism." First the beaver and the lowland game animals disappeared, recklessly slaughtered. The mines rarely repaid half the money sunk into them: no sooner was a camp established, with its own postoffice and stage line, than the lode ran out; today a dozen miles of abandoned mountain road lead to a picturesque ghost town. Creede richly recouped its investors, but left behind it unbelievable stagnation when

its mines were exhausted; Mineral County had in 1936 not a dollar in bank deposits to show for the fifty million that came out of the King Solomon veins;⁴ it has the second lowest county revenues and assessed valuation in the state of Colorado. The Rocky Mountain silver lodes contributed to a metal glut that ruined the world price structure and brought on the "free silver" chaos in politics: they made a few quick fortunes that were immediately removed from the country, and bankrupted thousands of the less fortunate. Worst of all, they left hillsides honeycombed, burned over, and barren as the moon; the smoke of forest fires rose often about the San Juan camps.⁵ Only one isolated stand of virgin timber remains in three million acres of natural woodland in the six counties; had the United States Forest Service not saved the watershed, it might have reverted by today to uninhabitable rock, silt, and sand.

Transportation presents an almost equally fantastic spectacle. General William Palmer first dreamed of a railway system that would reach from Denver along the Rio Grande and to Mexico City; bankers in London and Amsterdam were pleased enough with his plan to advance money. About 1879 the rails crossed La Veta Pass, reaching Alamosa and pushing on south and west: a spur went to Wagon Wheel Gap, whose hot springs were, it was hoped, to become an American Carlsbad; another line, complete with snowsheds, traversed the Continental Divide, making for Durango. During the 'nineties extensions were made to Creede and to Salida, supplying the mines; after them two independent feeder lines, the San Luis Southern and the San Luis Central, built into the new agricultural sections of the valley. Seven lines of track radiated from Alamosa—the beginning of a railroad empire that was never won. The promoters, lacking funds, abandoned their survey below Santa Fe; west of Durango the impassable Colorado canyons blocked the route; the spa at Wagon Wheel Gap never developed, and the mines were soon exhausted. The whole system was narrow gauge: sixty miles of track had to be relaid; the rest became obsolete. Today Alamosa is the only narrow-gauge terminal in the United States: it dispatches a Pullman train daily to Denver, and a mixed train to Santa Fe; freight service is offered, as rarely as semi-weekly, on the other routes; the two inde-

⁴ The Amethyst and other claims lay in this general area.

⁵ Hayden, F. V., *U. S. Geological Survey of the Territories*, Washington, 1873, ch. VII, VIII, comments on the situation.

pendent lines suspend service entirely through the winter. The Denver and Rio Grande system has been bankrupt for ten years.

The railroad builders overestimated the march of progress, yet their plan seemed in its day well-conceived. What should be said of the steamship, built in Alamosa to carry freight between river points, which sank at its launching because of structural defects, and would have infallibly been destroyed as soon as it reached the Black Canyon, that even a canoe has never passed? Only air commerce, the most carefully organized branch of transport, has no follies to its credit; there have been wrecks on the lower peaks of Utah and New Mexico, but no



FIG. 5. The Rio Grande enters its Black Canyon, 100 miles long and nearly 1000 feet deep. Close to the mesas in the background is the site of a prehistoric Aztec turquoise mine. Photograph by McKinney.

licensed air liner has yet adventured over the mountain walls of the San Luis Valley. There are, of course, available landing fields that may some day be used by stratosphere planes able to clear every obstruction and make one-stop flights from Chicago to the Pacific Coast.

Land companies have helped to make the agricultural history of the valley one of experiment alternating with disaster. Eight hundred farms were sold near Blanca, where there was water for only a fourth of the number; huge wheat developments began east of Mosca, but after a few successful seasons alkali poisoned the soil; greasewood and mesquite have overgrown

the whole area. Thousands of fruit trees were set out and blighted before farmers learned that orchards cannot survive June and July frosts. Small towns prepared to take care of a flood of immigrants, laying out streets and building hotels; Del Norte built its own astronomical observatory: the pretentious buildings have crumbled, and the streets are cowpaths. Nevertheless, a stable economy has grown up: potatoes in the irrigated central acres, with green vegetables in the protected canyons. Prices fluctuate, bringing huge profits and disheartening losses: after all of its banks had failed and tax warrants were far in arrears, Rio Grande County realized a million dollars' profit on its five-million-bushel 1936 potato crop.⁶ Whatever the price situation, five thousand carloads of produce are likely to be shipped from the valley in a season. Sixty per cent of farms are tenant-operated: the largest landlord, Costilla Estates, is said to own half a county, three reservoirs, and an interest in the S. L. V. Southern Railroad.

Livestock raising has gone on uninterruptedly; summer pasture is found in the national forest lands, and wild hay and stubble is available for the winter. Three huge ranches, the Trinchera, Medano, and Baca Grant, control half a million acres of the eastern range; the present government policy of restricting the forest grazing rights of large concerns will tend to increase the number of livestock holdings. Two million dollars' worth of cattle and sheep are held in the six counties.

THE FUTURE

Let us cast up, in conclusion, the balance-sheet of the San Luis Valley. Its greatest asset is water—and, presumably, hydroelectric power, though no power dam has been erected. Mining is not finished: Summitville and Bonanza have "come back" to yield a million a year by orderly development; some day a new process may suffice to extract gold from the Sand Dunes and the low grade gravels near San Luis; the Pueblo steel mills were for long fed with ore from the Orient Mine near Valley View; much remains to be mined as soon as cheaper deposits are exhausted.

The valley has numerous good libraries, a state college, and two daily newspapers; its people equal the numbers of Middletown, but they would seem to be culturally far superior—inde-

⁶ The highest price of potatoes in 1932 was 43 cents; in 1936 it stood at \$1.50; cost of production is about 55 cents.

pendent, alert, traveled, and tolerant: they are dominated by no dead tradition or living industrial dynasty.⁷ On the other hand, it has the social liability of absentee-landlordism and the drawback of inaccessibility; a surcharge is added to all commodity prices in the San Luis Valley for transportation "over the hump"; during storms, which occur as late as May, the whole territory is all but isolated from the world. Unfortunately, too, the valley has no "history" or exotic color: it was far off the route of the Long Cattle Drive or the Chisholm Trail; it offered no booty to outlaws, and was already a peacefully settled community when its mining "boom towns" sprang up. Hence the tourist goes to visit "Boot Hill," Pike's Peak, and Tombstone, but ignores Creede and San Luis. Taos and Santa Fe, close by, have surrendered to the spell of their own past, and become world centers. The San Luis Valley continues in a pitifully muddled manner to attract the sophisticated traveler, and also repel him. There are a few dude ranches where summer guests may practice an older way of life amid indescribably beautiful surroundings; a herd of buffalo has been saved on the Trinchera Ranch; the Red River Canyon has begun to attract the attention of Hollywood and Park Avenue. But the valley settlers continue to advertise only their cauliflower and lettuce, to pour sewage into the Rio Grande, to poach their own game!

To the Indians, the San Luis Valley was a summer playground; the early Spanish called it San Luis Park. Under a planned economy it would have been set aside as part of a game preserve and primitive area, stretching from Santa Fe north to the highest peaks of the Uncomphagres; this would have become a world resort, more popular than the Serengetti Plains of Tanganyika, attracting the naturalist, the poet, and the artist from the ends of the earth. As it is, a few eminent men have passed by; the words of one of the most famous are worth quoting:⁸

"There are all kinds of beauty in the world . . . but for a *greatness* of beauty I have never experienced anything like . . . (this) . . . I . . . stood in the fierce, proud silence of the Rockies . . . to look far over the desert to the blue mountains, blue as chalcedony, with the sage-brush desert sweeping gray-blue in

⁷ The Lynds' study *Middletown in Transition* is used as a basis for comparisons. Culturally, there can be no doubt that the more well-to-do residents of the valley are superior to Middletown's upper-middle-class set.

⁸ I quote from D. H. Lawrence, *Phoenix*, Viking Press 1936, pp. 143-144. He speaks of an area close to the southern boundary of the San Luis Valley. The words apply well to all of it.

between . . . The most aesthetically satisfying landscape that I know . . . ”

Is it too late to return the country to its manifest destiny? Its struggles for commercial greatness have been harsh and disillusioning. Little may be hoped for by following any longer the path of “progress”; perhaps it should be checked once and for all, the marginal ranches and exhausted farms given back to the elk and buffalo, the rails and highways, save for trunk lines, torn up, the swamps given back to breeding waterfowl, the streams purified.

AERIAL MAPPING

Aerial mapping is now reaching a stage of accuracy and speed which is destined to relieve the surveyor, with his transit and theodolite, of much of his roughest work. Jobs that would have taken him weeks can now be accomplished in a few hours by the use of a plane, a camera, and a new stereo-mapping projector which has just come from the Scientific Bureau of Bausch & Lomb Optical Co.

An automatic camera in the plane, shooting at regular intervals, makes pictures a mile apart. Terrain features are thus seen from different positions in succeeding photos just as the two eyes seeing things from slightly different positions get depth perception. If the two eyes respectively see the views taken a mile apart, the effect is as if the mapmaker had eyes a mile apart.

To achieve this, the 7×9” film negatives, each covering from the usual altitude of 20,000 feet, about 13 square miles, are printed on small glass plates about the size of two special delivery stamps. The utmost exactness is required in the adjustment of the instruments since a difference of one ten-thousandth of an inch might mean a difference of feet in the field. From the glass plates the picture is projected down on a drafting table by two adjacent projectors operating in red and blue light respectively.

With six separate adjustments on each projector set to produce exactly the same angular position that the camera occupied when making the corresponding negative, the mapper, wearing spectacles with one red and one blue lens, suddenly sees a single illusory three-dimensional model of the terrain on the table before him. The effect is so realistic that he may feel an impulse to pat the top of a smooth hill or prick his finger on a telephone pole.

To draw his map he moves across the drawing paper a fixture containing an illuminated pinhole mounted directly above a pencil. With this point of light set at a given height, the mapmaker moves the fixture about so as to keep the point in contact with the surface of the illusory ground. The line thus traced passes through all points where the ground is that high, resulting in a contour map.

The stereo-mapping projector will be used by the U. S. Army Air Corps, for military work and by government agencies and private mapping outfits for forest surveys, estimating timber stands, laying out logging areas, locating dam sites and camps and making topographic surveys. Aerial photography combined with the new mapping instrument reveals to the engineer with uncanny accuracy the problems with which he must deal.

A PROJECT IN HIGH SCHOOL PHYSICS

BY DONALD E. BUTLER

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and Junior College, Susanville, Calif.*

In practically every class group, whether it be the study of English, art, or physics, one finds pupils whose abilities enable them continually to be caught up with lesson assignments and ready to be on to further achievement. The type of work of these pupils is generally of high standard and no fault can be found with the speed with which they accomplish their work. However, in this day, when we all too often allow the slower, below average, pupils to govern the rate of class progress, the quicker and more apt pupils many times constitute a problem. If an instructor is conscientious, he will strive to find enough additional work related to the current class topic, of sufficient interest to the more advanced pupils, to excite their curiosity and stimulate further research.

The securing of suitable material for this sort of project work is sometimes quite difficult. This article is written in the hope that the project carried out in the physics class of the Lassen Union High School in Susanville, will be applicable in other schools where the science teacher is hard pressed to keep up the interest and enthusiasm of his "A" students.

During the unit on Electricity, we used for supplementary reference the book *Fun With Electricity* by A. Frederick Collins.* In it is a section titled, "Fun With High Frequency Currents." Here was given a detailed method for making a high frequency apparatus. High frequency currents or oscillations are electric currents that surge back and forth through a circuit about one-million times a second. In the application of modern physics there are many uses for a current of this type and in classroom demonstration such currents are invaluable in showing certain effects of electricity.

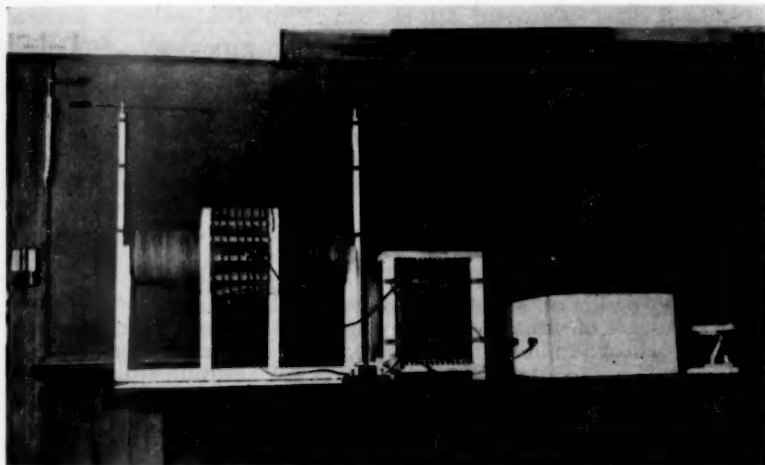
It was thought that the construction of a high frequency apparatus would provide an excellent project for the students in the class who were showing more than usual interest in the phenomenon of electricity. Daily laboratory work and exercises could be easily completed early and by studying and building this apparatus these pupils would put their extra time and talent to good use.

* Appleton Century Publishers.

Two girls and two boys, with the invaluable help of the students in the shop department, constructed the apparatus in two months' time, using a part of each regular class period and spending perhaps five extra periods apiece in the laboratory.

The type of apparatus constructed consists of four main parts.

- (1) A step-up transformer, which builds the 110 volt 60 cycle alternating current of the town circuit up to about 8,000 volts.
- (2) A condenser which stores the energy of this high voltage current to finally discharge it through a spark gap.
- (3) A spark gap which sets up the high frequency currents in the resonance circuit.
- (4) A high frequency Tesla coil, although the Oudin type coil might have been used.



A Tesla coil and operating accessories constructed in the laboratory.

Clear and full details are given in the book for the construction of each of these units. Some slight modifications were found advisable in the making of the high frequency coil; otherwise the apparatus was built as described in Collins' book. All of the materials except the hard wood were purchased through a large scientific supply company.

The most encouraging feature of this report lies in the fact that the total cost to the school for material and labor (not counting our own work as labor) was forty dollars and eighty cents.

An excellent X-ray tube and fluoroscope have long lain idle in our supply room. Now, by utilizing our new homemade high frequency source, we are able to extend our study and experi-

mentation in this very modern phase of electricity. Many other fascinating and spectacular experiments can be carried out in the heating and lighting effects of high frequency currents. Some of these experiments are the demonstrations of a brush discharge from the hand, from a wire, through a dielectric, or on a metal rod; the lighting of an electric lamp through a person's body; the lighting of Geissler tubes; the generation of ultra-violet rays and the studies of fluoroscopy. Even though an extremely high voltage is set up by the Tesla apparatus, the currents have no appreciable effect on the human body because they have such a tremendously high frequency and the amperage, or current strength, is very small.

EYE HEALTH COURSES AT BERKELEY

Anette M. Phelan, Ph.D., of the National Society for the Prevention of Blindness, will offer two college credit courses on educational aspects of eye health at the University of California, Berkeley campus, during the 1938 Summer Session, June 27 to August 5. The courses are sponsored by an Advisory Committee on Teacher Education in Eye Health of which the Chairman is E. S. Evenden, Ph.D., Teachers College, Columbia University. The purpose is to meet the need of school administrators and teachers for a better understanding of the eye health problems of school children.

One course will deal with the educational and health problems involved in the presence of visual defects among school children. This is open to teachers, school administrators, and nurses. A syllabus will be available. The second is a practicum for the study of eye health instruction in the curricula for teacher education. The enrollment is limited. Admission only with the consent of the instructor.

Dr. Phelan, the author of *A Study of School Health Standards*, 1934; *Conserving the Sight of the School Child*, 1935; and co-author of the Elementary School Series, *Adventures in Living*, 1937, was instructor in Health Education in Teachers College, Columbia University, 1926 to 1933.

ATOM SMASHING MACHINE BUILT FOR S. F. FAIR

A model cyclotron to smash atoms, which is being built by the University of California to be exhibited at the 1939 Golden Gate International Exposition promises to be one of the outstanding scientific sensations of the \$50,000,000 World's Fair of the West.

Present plans call for the cyclotron, which consists principally of two huge magnets, to be surrounded by a glass tank 35 feet in diameter. Through this glass the public may view its operations.

This cyclotron will occupy a prominent space in the Hall of Science at the Exposition, but University officials will augment that display with others on chemistry, astronomy, mathematics, medicine, botany, biology, oceanography and paleontology. The University exhibit will occupy one-third of the floor space in the science hall.

MATHEMATICS FOR A FOUR-YEAR COURSE FOR TEACHERS IN THE ELEMENTARY SCHOOL*

BY E. H. TAYLOR

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The most important period in the teaching of mathematics from the first grade to the graduate school is that of the first eight grades. First, because in this period all pupils are taught mathematics and probably forty per cent of them will receive no further instruction in the subject. Second, poor teaching here results in lack of knowledge and skill, distaste for mathematics, and the conviction that mathematics is difficult and requires special abilities. All of these results not only lead pupils to attempt to dodge mathematics but also contribute to failure in it in both high school and college, and to failure to transfer it to the solution of everyday problems. I believe there is nothing that can be done that will contribute more toward keeping mathematics in the high school and in improving the instruction there, than to improve the teaching of mathematics in the elementary school. There is much statistical evidence as well as general agreement that high school graduates have neither reasonable skill nor accuracy in the fundamental operations of arithmetic. That they are ignorant of the meanings of arithmetical concepts, operations, and symbols has received less attention, although this lack of understanding is fully as disastrous to good teaching as lack of skill, and much more difficult to remedy. I shall illustrate this ignorance of meanings by some results from a test on meanings in arithmetic given to freshmen at the Eastern Illinois State Teachers College.

My first examples show that students do not know what numbers and processes are indicated by the symbols of arithmetic. These results are from a test given to a class of 333 freshmen. Of this group 36% did not know the numbers represented by the digits 2, 3, and 4 in 2304, and 49% did not know the number represented by the 0.

In statements to be marked true or false,

31% marked $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ false;

22% marked $\frac{2}{3} = 2 \div 3$ false;

34% marked $\frac{2}{3} + \frac{3}{5} = \frac{2+3}{5+7}$ true.

* Read at the Annual Meeting of the National Council of Teachers of Mathematics at Atlantic City, New Jersey, February 25, 1938.

The following examples show lack of understanding of concepts and processes:

74% marked $\$12 \div \$4 = 3$ incorrect. In most such cases the quotient was changed to \$3.

22% marked $18 \text{ in.} \div 3 = 6 \text{ in.}$ incorrect.

95% marked $1 \text{ in.} \times 1 \text{ in.} = 1 \text{ sq. in.}$ correct.

70% failed to match exercises such as $\frac{3}{8} \div \frac{3}{8}$ with the proper graphical illustration which was given in a group of illustrations.

43% failed to solve: How many loaves of bread, each using $\frac{3}{4}$ lb. of flour can be made from 60 lb. of flour? The error usually consisted in multiplying instead of dividing.

It is evident that there cannot be good teaching of arithmetic until students preparing to teach arithmetic get rid of such errors as these.

What are the teachers colleges doing about it? What is being done to give future teachers of arithmetic the sound scholarship necessary to good teaching? I have discussed this question in two previous papers. In 1928 I examined the published curriculums of 187 normal schools and teachers colleges in 42 states to determine the extent and character of the offerings in arithmetic in those institutions. The study was repeated in 1935 for 128 such institutions in 39 states. The results show that there was a noticeable decrease from 1928 to 1935 in the number of semester hours of arithmetic offered, and also in the number of semester hours required in curriculums for the preparation of elementary school teachers. In 1935 no arithmetic whatever was offered in 12.5% of the teacher training institutions whose curriculums were examined, and none was required in at least 25% of the curriculums for the preparation of elementary school teachers. More than 50% of all the semester hours of arithmetic offered were given in courses devoted mainly or wholly to methods, and 11.6% of all semester hours offered were given by departments of education.

From the above studies it seems probable that at least 50% of beginning elementary teachers do not study arithmetic in college, and begin teaching a subject the science and psychology of which they are essentially ignorant, and of which many remain ignorant. How do I know they remain ignorant? I have found it out in attempting to teach arithmetic to hundreds of teachers with from one to thirty years of experience.

What should the teachers colleges do about it? A four-year course for the preparation of teachers for the elementary schools

should contain not less than eight semester hours of mathematics. Students who have not had two years of high school mathematics should be required to take an extra course. The required courses should deal in the main with arithmetic, but should not be called arithmetic both to avoid a bad label for those students who think that a course in arithmetic is below their level, and because these should not be courses in arithmetic in the elementary school sense. The aim of these courses is to prepare teachers of mathematics. They are not to give a review of the mechanics of arithmetic, but to present a new view, a teacher's view, that insures a mastery of concepts and processes and of methods of presentation to children; a view that unifies the subject matter; that makes prominent the aims of mathematics and the proper choice of materials for attaining them; and that through historical references and practical applications gives some knowledge of the development of mathematics and its place in human culture.

These courses should not be courses in methods only, if a methods course means the consideration of methods of teaching based on an assumed knowledge of arithmetic. The meanings of the fundamental operations with integers, common fractions, and decimals are a sealed book to college freshmen. Giving a course in methods of teaching arithmetic to a student who knows nothing of the significance of "borrowing" and "carrying," who looks upon the rules for placing of the decimal point and for inverting the divisor as either part of the law of the universe or magic, is folly.

Six-year-old children come to school with a considerable fund of mathematical knowledge; that is, knowledge of numbers and quantities and their relations. They can solve many problems in finding parts, and sums, and differences and multiples of quantities, using the quantities themselves. Too frequently when they enter the school room their attention is taken away from numbers and quantities and centered upon symbols. They have an eight year course in symbols, and are expected to emerge knowing some mathematics. Some of them do, perhaps in spite of the instruction and not because of it.

What per cent of teachers college freshmen, or seniors, or of elementary teachers of two years' experience can illustrate correctly how to find these quotients:

- (a) $12 \text{ marbles} \div 3$
- (b) $12 \text{ marbles} \div 3 \text{ marbles}$

- (c) $6/8$ of a rectangle $\div 2/8$ of a rectangle
- (d) $6/8$ of a rectangle $\div 2$
- (e) $3/4$ of a rectangle $\div 2$
- (f) $3/4$ of a rectangle $\div 1/3$ of a rectangle
- (g) $6\frac{1}{2}$ ft. $\div 1\frac{1}{4}$ ft.
- (h) $\$.12 \div \$.02$
- (i) $\$.12 \div 2?$

The answer is, a very small per cent. But without ability to show what these questions mean in the concrete, division cannot be taught rationally, hence pupils do not learn what division means, and therefore do not know when and how to use division in the solution of problems.

I have used division to illustrate the need for understanding. Any one of a score of other topics might be used. Whatever our theory and practice concerning the rationalization of number processes for children may be, it seems indisputable that the teacher should be able to rationalize and illustrate these processes. Without this ability the teacher cannot have certainty of judgment, choice of method, facility of illustration, or the easy mind that is a necessary condition for good teaching. Without understanding, we have formal and mechanical teaching, the bane of mathematical instruction. College students do not think of arithmetic as a science. It is a bag of tricks. Their understanding of the reasons underlying arithmetical processes is little better than that of sixth-grade children. Over and over I have heard their expressions of surprise, mixed sometimes with disgust, that instruction in the grades had not emphasized meanings.

A course in the mathematics of the elementary school can be made of college grade, scholarly, stimulating, with both cultural and professional value, and such as to command the respect of students. Quite recently I heard a high school teacher, one of the brightest students in mathematics that I have ever taught, speak with appreciation of such a course. He spoke in particular of the fact that the science of the elementary processes of arithmetic was a new field for him even as a college student, and of the value of the course in his teaching of elementary algebra, where so much attention has to be given to the teaching of arithmetic.

I have emphasized in this paper the characteristic of a course in mathematics for elementary teachers that seems to me to be the most important, and also the least likely to be emphasized,

judging from printed curriculums. Such a course should also consider the purpose, organization, and content of mathematics in the elementary school, the contribution of mathematics to the individual and the race, modern tendencies in teaching and organization, and other related topics.

If, as I have tried to show, (1) students entering teachers colleges are deficient in both the mechanics and the understanding of arithmetic; (2) the offerings and requirements in mathematics for elementary school teachers are on the decline; (3) the success of mathematics throughout the school system depends upon the quality of work done in the elementary school; then this organization, as well as the Mathematical Association of America and the American Mathematical Society have an important work in attempting to improve the preparation of teachers of mathematics in the elementary school.

EMERALDS MINE REOPENS

Glittering green emeralds, torn from the rocks of North Carolina, will soon appear on the gem market, according to plans recently made by Edward Fortner, mining engineer, who has recently reopened the long-abandoned emerald mine 15 miles south of here. Unwatering of the 250 foot shaft will begin in a few weeks.

Emeralds produced in the past by this mine have been of gem quality, but too small to have much value. Working on the well-known geological principle that the size of mineral grains in dikes like those at Spruce Pine increases with depth, the present operators plan to deepen the shaft, hoping thereby to find larger, and more valuable, emeralds.

Long a producer of semi-precious stones, the Spruce Pine region may soon, if the emerald size increases according to theory, supply precious stones to the American market. Several emeralds from nearby areas are now in the U. S. National Museum, in Washington.

AMERICAN EDUCATION WEEK 1938

The program for American Education Week 1938 has just been announced by the National Education Association. This program has been adopted by the three national agencies which sponsor American Education Week—the National Education Association, the United States Office of Education, and the American Legion.

General Theme: *Education for Tomorrow's America*

Sunday, November 6—Achieving the Golden Rule

Monday, November 7—Developing Strong Bodies and Able Minds

Tuesday, November 8—Mastering Skills and Knowledge

Wednesday, November 9—Attaining Values and Standards

Thursday, November 10—Accepting New Civic Responsibilities

Friday, November 11—Holding Fast to Our Ideals of Freedom

Saturday, November 12—Gaining Security for All.

ONE THOUSAND AND TWO CHILDISH QUESTIONS¹

BY HANOR A. WEBB

Department of Science Education

George Peabody College for Teachers, Nashville, Tenn.

Many centuries ago the "Tales of 1001 Nights" were told by a beauteous Arabian favorite, Scheherazade, who kept a bored old Sultan on his mental tiptoes for three years, and saved her own lovely neck. Last year *this* Sultan of Science, your speaker, was kept on the alert for at least three months through tidbits of interest—by strange coincidence 1002 in number—that came to the editorial desk where a weekly classroom paper, *Current Science*, is written. High school students from forty states sent these in under a title worthy of an Arabian Nights' story—"Lost Jewels of Scientific Knowledge."

Like most good things, the idea originated in a true necessity. In writing an article, the editor got stuck for the scientific designation of a baby turkey, to distinguish it from the older birds. Searches in several dictionaries and encyclopedias proved fruitless. Yet Adam, on the Day of Creation, definitely had given names to all the beasts of the fields and the fowls of the air. Among infant animals there were the puppy, the kitten, the cub, the colt, the chick, the gosling; assuredly Adam had not overlooked an appropriate title for the potential white-and-dark meat of Thanksgiving Dinner. And surely, among some of Adam's descendants, this word that the dictionaries and encyclopedias forgot must have been handed down by word of mouth, from grandmother to daughter to granddaughter!

It was decided that the question be put to the country. A "Lost Ad" was inserted in *Current Science*, reading: "The editor has lost a jewel of science information. He has looked in many books, but he cannot find what a baby turkey is called. If any student finds this jewel, send it to *Current Science*, telling where you found it, or who told you. A reward will be paid for the one who sends us the most complete information."

Answers swamped the editor's desk. This "jewel of information" had been hidden in forty-four states, and was found by hundreds of earnest searchers. This editor was well-told where he could have obtained the information that a baby turkey is a

¹ A paper read before the National Council on Elementary Science, Philadelphia, February 26, 1938.

poult. Specific dictionaries were cited; books on animal husbandry were quoted; clippings from farm magazines were sent in abundance; and even whole poultry catalogs arrived. He was told that if he would read *Lorna Doone*, the word would be found.

The earnestness of the researchers of tender years was impressive. One student wrote that (like the editor) he did not know but was determined to find out. "I took the dictionary," he explained, "and began with A. Looking at every word on every page, you can imagine how happy I was to find *poult* on page —." Frankly, the editor had thought of doing this very thing, but was afraid that the baby turkey's name might begin with z.

Another student explained that he asked his kinfolks of an older generation, also a poultry raiser. All gave the same word; but to be *sure* (incidentally, this boy was from Missouri) he looked up the printed word as well. He wrote: "I asked five people, then looked in three encyclopedias, one dictionary, one poultry book. I am now *sure* that a young turkey is a *poult*."

All search was not successful, however. One young girl gave the editor all the information she had, thus: "I can't find any special word for young turkeys, but when you call 'pee-wee! pee-wee!' they come."

The successful recovery of this lost jewel of scientific information gave the editor an idea that perhaps, in the minds of students throughout the States, there were lacunae of curiosity which they would be happy to have filled. As a feature of *Current Science* the "Lost Jewel" column was continued for several weeks, inviting students to send questions of broad science that interested them, and for which they had been unable to find the answers in texts and school encyclopedias. As a second thought, the editor asked that the titles of the reference books, consulted without success, be given, also the names of any persons asked. It was the editor's fond hope that science teachers might have information to offer.

Again the letters flooded the editor's desk. At the close of the "jewel hunt," one thousand and two gems had been received from forty states—items of scientific fact about which contemporary youth puzzles, for which they have found no answers.

The first sorting inevitably eliminated certain questions from the attempted scientific analysis. There were the to-be-expected facetious questions, as the perennial first-hen or first-egg problem, how high is up, whether a house burns up or down, what

wooden nickels are worth in change, and the uses of chewed chewing gum. Of course someone wanted to know what "pneu mono ultra microscopici silico volcano koniosis" means. Then there was the Persistent Punster who, each week, sent the editor a smarty question such as: "Here is a *foxy* one for you, Mr. Editor: what is the name of a female fox?" and "Now I'm going to *snake* up on you; how long can a snake live between meals?" To the credit of science-minded American youth, however, it can be stated that from 1002 questions, only twelve were deliberately funny. The Ed Wynn-Eddie Cantor influence is not seriously permeating the science classes.

Of course the baby turkey question set the copy-cats to work. There were a baker's dozen of requests for the names of baby pelicans, baby penguins, baby beavers, baby giraffes, and the like—even for the name of a baby aardvark!

Several other questions had to be eliminated as irrelevant—and all of these were sent in by one student whom I shall call Conscientious Kate. Perhaps her education was already completed for ordinary matters in science, but she set herself down to the dictionary and produced a list containing the queries: "Who invented the anemoscope; who invented the anemometer; who invented the anonthoscope; the astrophotometer; the audiometer; the auniscope, etc." She promised to carry on through the B's the next week, and farther—but to the editor's relief, she soon gave up the idea.

The eliminations, for various reasons, brought the studiable total of questions down by about 50. The remaining "lost jewels of scientific information" have been studied carefully as to content, and arranged in appropriate classifications. Be reassured; these will not be presented in detail in this address.

It was quickly evident that while a few questions relating to abstractions were asked, the overwhelming majority were interested in applications of science. For one student who asked about the exact laws of van't Hoff and Le Chatelier, there were fifty who wanted to know such facts as why boiled water froze quicker than unboiled water in the refrigerator; for one who wished to know the theoretical cooking temperature of an egg at sea level at the Equator there were many who desired information on such useful items as why ground beef is known as Hamburger; for one theoretical question about the force of electromagnetism there were a score involving the personal magnetism to be fostered by beauty culture and the sources of these cos-

metics. To match every insipid "Who was the first person to discover that there is no sound where there is no ear?" there would be at least a dozen questions with real teeth—as "Who was the first man to wear a complete set of false teeth?"

In every analytical study it is hoped that small data may yield large views. Working over these questions, no unique aspect of youthful psychology has been discovered, much less a imperative need for revision of our science curriculum. There is a surprising lack of curiosity in certain great areas that we may have thought interesting to youth. There may be a serious inadequacy of typical school references—remember, these are 1002 questions unanswered after search—as to practical information in certain fields of science.

A few generalizations seem appropriate interpretations of these questions. First, practically no regional influence is evident in the queries that came from coast to coast. Only a few bore a postmark in their content. A boy from Oregon asked, "Who christened grizzly bears 'grizzly'?" A rookie from Plymouth-by-the-Rock has long been wondering, "Why are ships called 'she'?" A scion of the Deep South sent in a query of local importance, "What is cotton's native country?" These, however, were the exceptions. In a notable number of cases the same question was echoed from many quarters of America. Students in New Jersey, Missouri, Alabama, and Montana wished to know about the inventor of the first clock. "How did the artesian well get its name?" was equally interesting in South Dakota and Georgia. The origin of the telescope was not clear and information on the matter not available to students in Idaho, Tennessee, and Minnesota. A question concerning carbon paper duplicated itself in New York and California. A boy in Wisconsin and a girl in South Carolina were equally involved in the "why" of the twist in a pig's tail.

These details are evidence of the homogeneity of North America, a general uniformity of intellectual advancement, on the high school level, in this Land of the Free and Home of the Brave. Perhaps it may no longer be said—as was admitted a generation ago—that a textbook written by a New England author would be wholly unintelligible to other large areas of our nation. Compulsory education, and the practically complete passing of illiteracy, has nearly made us one nation, scholastically. Possibly a more desirable political and economic solidarity may follow in due time.

Questions about machinery, electricity, and invention came from distinctly agricultural sections of the nation; from urban centers there were inquiries about birds, insects, and animals. With our modern annihilators of space—the automobile and the radio—there need be little distinction between town and country in the future science offerings in our public schools.

Second, the questions apparently reveal a lack of interest in the spectacular developments of science and invention since the World War. One might have anticipated a wide variety of questions about airplanes, the radio, television, the movies, and the like. By actual count, however, of the 1002 "lost jewels," only 6 concerned air transportation, a mere 7 inquired about the clamorous radio, the thrills of television brought but 2 questions, and in regard to the ubiquitous movies there were only three things to be asked. Is it possible that, in respect to this current magic of applied science, our youngsters already know all the answers? Is it probable that the boy and girl of today, who possesses scientific curiosity, is kept so well informed through feature articles in newspapers and magazines, through radio programs, movie shorts, and the like, that his interest in current developments is nearly satisfied, and there is little left to be curious about? Should some of us who have tried to be particularly active in presenting up-to-the-minute science in text, magazine, syllabus, or lesson plan, feel that we are doing the job too well?

The lone three questions concerning the movies give a hint of a third generalization. These questions were: "Who made the first movie?" "Who acted in the first movie?" "Who first produced a talking movie?"

The word *first* gives the clue. Like echoes, question after question was asked concerning a first event: "Who first wore shoes?" "Where were buttons first used?" "Who invented the first saw?" "Who first found diamonds; when and where?" "Who made the first toothbrush?" "Who was the first man to take a dose of medicine?" "Who discovered the dairy cow, and first learned how to milk her?" Throughout the reading there developed an almost rhythmic underbeat of "first"—"first"—"first, first, first!"

Now we teachers belong to an earlier, simpler generation. Most of us were born under conditions by no means luxurious. Our formative years were doubtless passed in environments that may be considered primitive in comparison to our living

quarters of today. An evocation of our childhood brings memories of cutting wood or bringing in coal for grate fires or the cooking stove; of heating water on this stove for the weekly bath in a small tin tub; of churning butter on the back porch, after bringing milk from a far-away spring house; of participating in an orgy of fruit and vegetable canning in season. Some of us, even, have curried a horse, and put his harness on before daylight through our sense of feeling. We grew up in an America that had by no means completed a transition from pioneer days. *We* do not ask *ourselves* the questions: "Who first baked bread?" "Who invented the first chair?" "Who made the first stepladder?" *We* realize that few of the accessories of living have sprung, full-developed, into being. *We* appreciate all of the evolutionary steps between the caveman's bed of leaves and skins, and the beautyrest mattresses of today.

The children that we teach do not possess this fundamental concept. Because of the way we have taught them, they believe that, beginning with a certain moment, ice cubes have popped plentifully from automatic refrigerators. It is their belief that the day after the first milk bottle was made, every doorstep was decorated with a bottle of milk. They have heard of a period when there were no traffic lights, but that period was over the day after someone—who was he? they would like to know—invented the traffic light.

This has been our fault. We have overemphasized Morse, who invented the telegraph apparently out of nothing, but we have failed to mention that already there had been several systems of electrical signaling which were almost practical, and that Morse had a pencil in his first receiver to write the message on paper. We have stressed Edison's invention of the electric light without mentioning that other filaments had already gleamed. We have not adequately traced for our students the progressive attempts of man to light his dwelling throughout the ages, or presented certain fundamental improvements of the light in recent times. From our teaching, from our textbooks, reference books, and other science literature of today, our youngsters have received the idea of invention as a sort of catastrophe similar to Creation, rather than a process which is definitely Evolution.

The editor was gratified that when so many hundred children volunteered to send in notices of "lost jewels" of scientific fact, they looked around them and realized that the things they knew least about, yet found most interesting, were common articles of

everyday living. He is distressed that so great a number were apparently curious about isolated facts, chiefly "first facts" analogous to a name and date in dry-dust history. He would have much preferred that one had asked, "How does an electric clock work?" rather than "Who made the first electric clock?" Would it not have been a sign of better science teaching if the question "Who made the first butter?" had been "What makes butter stick together?" Are we arousing the proper adolescent curiosity when we receive the query, "Who invented the first bird cage?" instead of "Do canaries require vitamins in *their* food?"

Had the "Lost Jewel" column continued longer in *Current Science*, the 1002 questions would have been multiplied many-fold. But one day the editor received a question designed to end all questions. The Persistent Punster climaxed his many notes with this: "Dear Editor," it read, "I've lost another jewel, and believe me, it is a gem! Here it is: 'Who thought up this lost jewel business anyway?'"

STANFORD UNIVERSITY EDUCATION CONFERENCE

"Social Education" will be the theme of the 1938 Stanford Education Conference, to be held at Stanford University, California, July 6-10. Among the leaders in American education who will take part in the program are *William Heard Kilpatrick*, Emeritus Professor of Education, Columbia University; *Lewis Mumford*, author and lecturer; *William Ogburn*, Professor of Sociology, University of Chicago; and *Ray Lyman Wilbur*, President of Stanford University.

Forum sessions during the conference will be devoted to discussion of experiments, investigations, and programs in social education and social control; to appraisal of practices and trends in the field; and to interpretation of the educational implications of American culture. The conference has been organized especially to appeal to those interested in guiding American youth to think creatively and act cooperatively in solving our social problems.

There will also be held, July 5 and 6, a Conference on Early Childhood Education to commemorate the 100th anniversary of the founding of the kindergarten. Among the leaders will be *Winifred Bain*, New College, Columbia University; *Julia L. Hahn*, Supervising Principal, Washington, D. C.; *William Heard Kilpatrick*; and *Lois Meek*, Professor of Education, Columbia University. The conference will stress growth needs and social direction and is planned for parents, health workers, nursery, kindergarten and primary teachers, social service workers, and school supervisors and administrators.

This is the sixth summer during which a conference on some phase of guidance, administration, or curriculum development, has been held on the Stanford Campus. Attendance at these conferences has increased from a few hundred in 1933 to over 1200 in 1937. Information as to fees and other details may be secured by writing to Stanford Education Conference, Stanford University, California.

ADOPTING A METHOD OF BALANCING OXIDATION-REDUCTION EQUATIONS

BY RALPH E. WELLING

Dorchester High School for Boys, Boston, Mass.

By adopting a definite method of attack, students should be able to overcome difficulties with a minimum loss of time and a maximum of understanding. The variety in method by which the gain and loss of electrons in oxidation-reduction equations is presented to students in articles and texts seems very confusing. To teach this topic to the best advantage of the students the instructor should adopt a single successful method and insist, by using it constantly that it become a practical tool.

The method presented in this paper has been learned by students and used with remarkable ease throughout their courses during the past nine years at the Dorchester High School for Boys.

By way of introduction, the teacher should demonstrate on the blackboard that there is never a single valence change in equations involving a double decomposition or a simple decomposition of unstable compounds such as carbonic acid, sulfurous acid, ammonium hydroxide or ammonium carbonate.

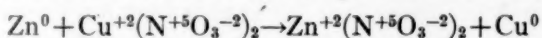
The next step should be the unfolding of the method of attack upon equations involving oxidation-reduction, that is, a loss and gain of electrons.

Let us choose first an equation involving a simple replacement.

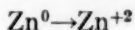


It is best to begin with an equation in which one is the only coefficient.

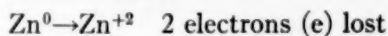
First we write the valences of every element in the equation.



Secondly, we take the first element we meet that is seen to have changed its valence and we write

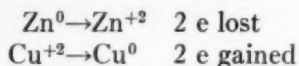


This is read, "Zinc, zero, becomes zinc, plus two." After this we write the valence change:

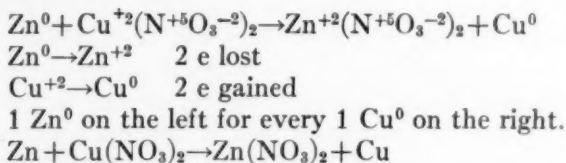


Beneath this we place the next valence change and what it

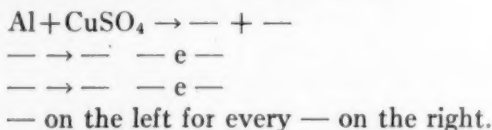
means in terms of electron loss or gain. Thus:



Next we interpret the meaning of this as follows: To balance the equation we need one Zn^0 on the left for every one Cu^0 on the right. Given this fundamental fact we can easily balance the equation. The model, which should be written on the blackboard is:

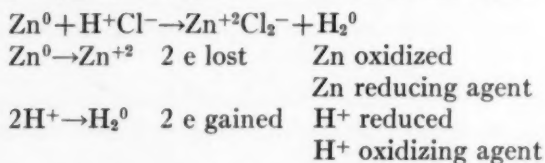


At this point, another example such as aluminum plus copper sulfate, should be written on the blackboard and the remainder of the model represented by dashes as follows:



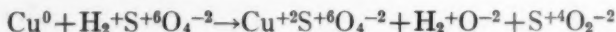
The balanced equation is: $\text{---} + \text{---} \rightarrow \text{---} + \text{---}$.

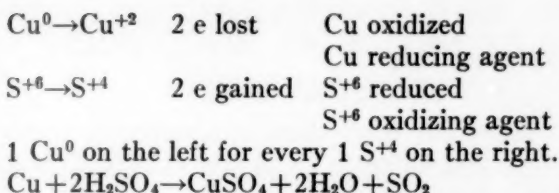
For our second model let us select an equation in which hydrogen, oxygen, nitrogen, or chlorine is involved.



We note two points that did not appear in our simple replacement equations. These are: (a) The element that loses electrons is oxidized and therefore is a reducing agent. The element that gains electrons is reduced and therefore is an oxidizing agent. (b) In recording the valence change of the gas formed we write H_2 and multiply the H by two. This procedure is simple and perhaps less confusing than many other methods of showing the gain of two electrons.

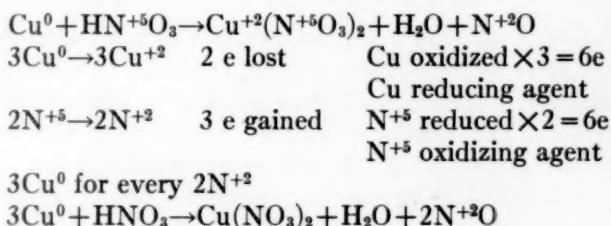
Our third model is based on the case where a gas composed of two elements is evolved.



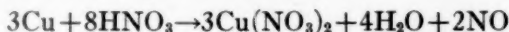


This example adds another point to our attack. Notice that only some of the S^{+6} changes to S^{+4} . We will, therefore, need only one Cu^0 on the left of the equation for every one S^{+4} on the right. The teacher must take particular pains to make this fact clear.

For the fourth model we may select the action of copper on dilute nitric acid.



The balanced equation must be:

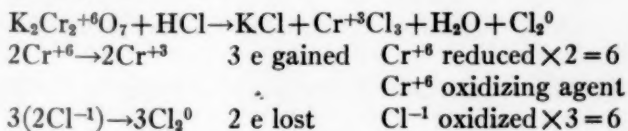


Here other points in the attack are developed. First we note that to have the same number of electrons gained as lost we must multiply the copper by three and the nitrogen by two. Only after we have written the numbers to the right as in the model, should we write the figure three before the Cu^0 and the Cu^{+2} and the figure two before the N^{+5} and the N^{+2} .

Secondly, we have an opportunity here to review the fact that only part of the original positive element changes its valence.

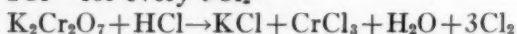
Thirdly, we call to the students' attention that it is necessary to write only the valences of those elements which undergo a valence change.

In secondary school chemistry we need go no further than one more model. Let us take the case of an oxidizing agent and hydrochloric acid.

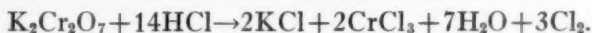


Cl⁻¹ reducing agent

2Cr⁺⁶ for every 3Cl₂⁰



Once the above partially balanced equation is written the student can see that he needs 2KCl and 2CrCl₃. This adds up to 14Cl on the right and the balanced equation is:



SOME EASY PROJECTS IN CHEMISTRY

PROJECT 2—OZONE

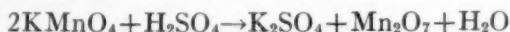
BY WILLIAM GIEGOLD

Senior High School, Orlando, Florida

Ozone is an allotropic form of oxygen and has the formula O₃. It is much more active than oxygen, O₂, and is a very powerful oxidizing agent. This can be demonstrated by some simple, safe, but effective experiments. First we prepare the ozone.

Put one or two grams of potassium permanganate crystals into a small beaker or tumbler. Moisten the crystals with a few drops of water. Now stir in two or three cc. of concentrated sulphuric acid. Notice that there is quite a vigorous reaction. Purple vapors will arise which are probably small particles of the permanganate since the ozone itself is colorless, but you can smell the ozone.

The equation is:



The manganese oxide breaks down into manganese dioxide and ozone.



Now invert an unlighted Bunsen burner into the beaker, stand back, and turn on the gas. *There will be a slight, harmless explosion* and the gas will become ignited. This shows how very vigorous is the oxidizing action of the ozone.

Put a few drops of carbon disulphide into a watch glass. Touch the end of a glass stirring rod to the material in the beaker and then touch the end of the rod to the disulphide; it will be ignited. Alcohol or ether may be used in place of the disulphide.

A bright silver coin held in the escaping ozone in the beaker will become tarnished.

TEACHING FIRST AID AND ARTIFICIAL RESPIRATION IN BIOLOGY CLASSES

BY R. C. WILKINS

Central High School, Superior, Wisconsin

Educators are advocating that we teach practical and functional material which is closely related to the present or immediate future needs of the child.

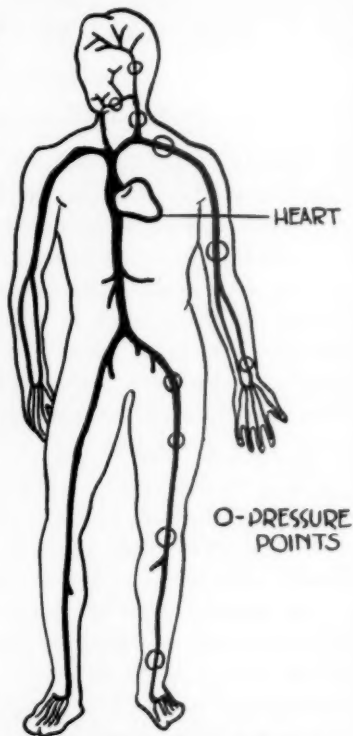
Certainly in these times of frequent accidents a knowledge of proper first aid treatment is practical and desirable. Every twelve minutes there is an accident upon the highways; there were 99,000 fatal accidents in the United States in 1935. Of this total 14,000 involved children under fifteen years of age. There are nearly 5,000,000 accidents in the homes of the nation each year. If we add to this list accidents connected with swimming and other water sports it becomes clear that everyone should know what to do for an injured person until professional help arrives. It is not safe to assume that people know what to do because many either do nothing or do the wrong thing.

No great amount of technical knowledge is needed to teach this material. Probably the best source material is the *Red Cross Text-Book of First Aid* which may be secured by sending sixty cents to the Maple Press Company, York, Pennsylvania. Members of the local "Red Cross" unit usually can supply such material.

This manual explains the Schafer method of artificial respiration and also gives a chart showing "Pressure Areas" where the arteries are near the surface and how bleeding may be stopped by pressing on the proper point with the fingers. This manual also includes a wealth of material on other aspects of first aid such as treating burns, and poisoning, and proper bandaging.

The procedure used by the writer is to introduce the subject early in the school year. Various approaches may be used such as a newspaper account of an accident, or in the study of oxygen or respiration. Interest may be aroused by asking how many swam the past summer and if there were any accidents. A discussion to bring out the importance of knowing how to act in case of an accident, should follow. Often there will be boys who know how to demonstrate the Schafer method of artificial respiration, which is used in any case where breathing has ceased; as a result of shock, drowning, or gas fumes. The instructor should know what points to stress, some of which are:

1. See that any foreign material is removed from the mouth and that the tongue is not back in the throat where it may interfere with breathing.
2. Keep the patient warm at all times and send for a physician as soon as possible.
3. Speed in starting artificial respiration is extremely important as the loss of a few seconds materially reduces the chances of restoring breathing.
4. The patient should be extended with face downward, the head resting on the back of one hand with the face turned so that it can be seen by the operator.
5. The operator kneels straddling one of the patient's thighs so that when he sits back in a resting position the palms of his hands can be placed on the small of the patient's back with the little finger just touching the lower rib or the tips of the fingers touching the shoulder blade.
6. The operator then swings forward gradually placing the weight of the shoulders and upper body on the patient. The arms are kept straight and part of the weight is supported on the knees with the thighs perpendicular. Avoid too much weight or pressure, especially upon a child. In practice the patient can help determine the proper weight and tell if air is being forced in and out of the lungs.
7. The forward swing should take about two seconds. The operator should avoid pushing himself up with his arms but snap the hands away to the sides and support himself on his knees. Proper timing and rhythm is important and can be secured by counting five slowly or saying slowly "Out goes the bad air" on the forward swing and "In comes the good air" on the backward swing. The total operation should take five seconds.
8. Stress the need of persistence without interruption until complete natural respiration is restored. Breathing has been re-established in some instances after eight hours of treatment so do not give up too soon and be sure that respiration does not cease, once it has been restored.



FROM DEABODY AND HUNT,
"BIOLOGY AND HUMAN WELFARE"

If laboratory tables are available these may be used for demonstration and practice. We also have used the floor, on which blankets, mats, or cardboard may be placed. We have used the tables in the school dining room and when weather

permits we go outside on the grass. Girls seem to prefer the floor rather than tables. Every pupil must serve as operator and patient, a few may be shy at first but if it is understood that everyone is to take part, little difficulty is experienced. If possible, pair the pupils and have them all practice at once, this lessens the embarrassment which some feel at acting before the class. There will be some fun and freedom which is not objectional but the instructor must give the idea that it is important work and that correct technique is demanded. In some cases it works best to have boys in one room and girls in another or at least in different ends of the same room. The idea is to keep every one busy and to walk among them correcting mistakes and giving encouragement.

Practice is essential, no amount of observation will give the proper muscle sense and technique. Urge the pupils to practice at home. Interest often runs high and here is where the pupil, "Slow in books" has opportunity to excel.

At least once a month during the rest of the school year we take time to practice and it is surprising how much efficiency has been lost—which emphasizes the need for practice.

In teaching how to stop bleeding from a wound we use the chart in the Red Cross Manual. This can be passed around the room, drawn on the board, or if you have a large chart of the human body, the points may be inked on this chart. The entire class then locates the "Pressure Areas" by feeling of the pulse. Stopping bleeding by this method is usually better than applying a tourniquet.

An interesting procedure is to have one pupil locate the pulse in the wrist of another pupil then by applying pressure to the artery at the elbow the pulse beat can easily be stopped, thus proving the effectiveness of the pressure method. It is well to emphasize the fact that the pressure must be released at frequent intervals so that circulation will not be prevented for too long a time in the area beyond the point of pressure.

EACH MILE EARNS \$850

A yearly income of \$850 per mile in the form of taxes on gasoline consumed in passing over it is yielded by a highway on which 700 vehicles per day travel, *Public Works*, a journal, points out.

The income is figured on the basis of a gasoline tax of at least five cents a gallon and gasoline consumption of 15 miles to the gallon. Both are conservative estimates, it is claimed.

DEMONSTRATING THE RELATION BETWEEN KINETIC ENERGY AND VELOCITY

BY H. LYNN BLOXOM
High School Ft. Dodge, Iowa

There is a stretch in the high school physics course that tends to be rather mathematical, and a perusal of catalogs will show them to be mostly barren of helpful demonstration equipment. This article is the outcome of a personal effort to fill in some of this gap.

It is comparatively easy to pick up a piece of chalk and develop the equation, $Fs = MV^2/2g$, from simpler and more or less axiomatic expressions. The mathematically minded student will usually agree with the outcome, but the others—if they bother about it at all, are likely to wonder how it might concern anyone, anyhow. It is for this majority of little mathematical

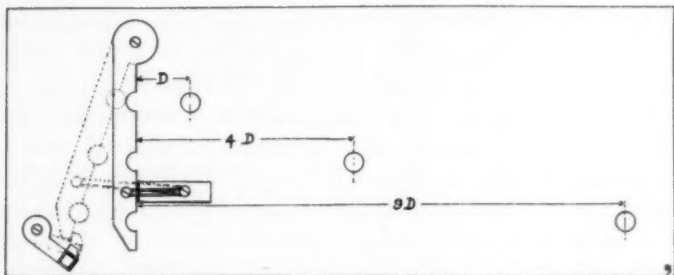


FIG. 1

inclination—who have the best reason for knowing the significance of the equation—that the demonstration to be described, is recommended.






In Figure 1 is shown a smooth flat board provided with an arm which is attached at one end by a loosely fitting screw, so that the arm is free to swing through a small arc. In the arm there are three or more semicircular notches that are placed so that their centers are spaced from the screw in the ratios, 1:2:3:n. There is a small block between the second and third notches that serves as a positive stop as the arm swings toward the right. On this block, and on the arm are small screws or tacks around which a rubber band is stretched, so that if the arm is drawn back to the position shown in dotted lines, it will snap back against the block when released. There is provided

also, a catch to hold the arm back in the dotted position. Three circular blocks, or chips complete the outfit.

To operate the device, the arm is latched back in position. The chips are then placed well back in the notches—which should fit them loosely. When the arm is released, the chips are sent sliding along the board with velocities that are in proportion to the arcs through which they have traveled. These arcs are likewise proportional to their respective radii, or 1:2:3. The time during which speed is acquired is the same for all.

The distances traversed by these chips in coming to rest are not proportional to their velocities, however. That is the point to be established by this experiment. If a number of trials are made and the resulting distances averaged respectively, they will be found to run in the ratios 1:4:9. In order to establish proportionality, it is necessary to square the velocities. When this is done, the distance traversed by a chip, divided by its velocity squared, gives an answer that is equal to that obtained by dividing the other distances by the square of their respective velocities, or $D/V^2 = a$ constant. That is the test for proportionality.

An ideal set of data might, for instance, look like this:

Distances(D)	Velocities(V)	D/V^2
$D_1 = 8$ cm.	$V_1 = 1^*$     	$8/1 = 8$
$D_2 = 32$ cm.	$V_2 = 2^*$	$32/4 = 8$
$D_3 = 72$ cm.	$V_3 = 3^*$	$72/9 = 8$

(*Arbitrary units)

The force of friction retarding the three chips is rather constant regardless of velocity and may be considered practically the same for all trials, for all of them. (Authority for that can usually be found in previous experiments on friction.) The masses are likewise practically equal. It is fairly well established then, that the energy required to stop a moving body, varies as the square of the velocity, or, $Fs = MV^2/2g$, when the answer is to come out in familiar work units.

The most important implication for the majority of the class to consider—in view of the growing difficulty in securing driver's licenses and the mounting highway accidents—is, that a car having doubled its speed, will require four times the distance in which to stop. When the speed is tripled, the stopping distance is nine times as great. A speed of 30 miles per hour, where the legal speed is 25, does not seem like seriously breaking the

law, but figured in *braking* distance the legal limit has been exceeded by nearly 50%.

The previously described apparatus is most suitable for individual experiments, where small equipment is desirable. Figure 2 shows how the apparatus may be built for class-room demonstration, so that all may see at one time. The principles involved are the same as have been discussed, and the diagram is

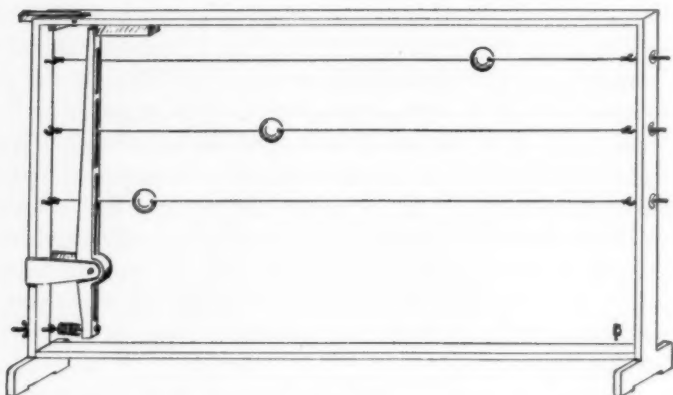


FIG. 2

sufficiently self-explanatory that no one should experience difficulty in setting it together and obtaining figures that at least roughly demonstrate these important laws. Proper treatment of this subject, may at least postpone the mishap, into which it is predicted a large proportion of our automobile driving students will be plunged.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

The National Council of Teachers of Mathematics will have its fourth summer meeting with the N.E.A. in New York City June 27, 28, 29. The general theme of the three day session will be "Mathematics that Functions." The general plan is as follows:

1. "Progressive" Arithmetic Teaching, June 27, 2 p.m.
2. "The Forgotten Pupil," a joint meeting with the Department of Secondary Education, June 27, 3 p.m.
3. Discussion Luncheon, June 28, 12:30 p.m.
4. "Progressive" High School Mathematics, June 28, 2:30 p.m.
5. Mathematics as it Functions in Business and Industry, June 29, 2 p.m.

Details including speakers, places of meetings, reservations for luncheon will appear in the May issue of the *Mathematics Teacher*.

GEOMETRICAL CONSTRUCTIONS ARISING FROM SIMPLE ALGEBRAIC IDENTITIES

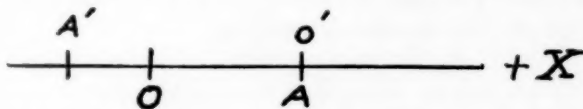
BY I. A. BARNETT

University of Cincinnati, Cincinnati, Ohio

It is the purpose of this paper to give some supplementary work in geometrical constructions which may be utilized at the end of a course in plane geometry. The properties of the figures constructed would require considerable proof if one did not know the algebraic origin of the problems. All these constructions can be effected by a finite number of steps, using straight edge and compasses only, and the proofs of the relationships of the configurations depend only upon the knowledge of the properties of similar triangles.

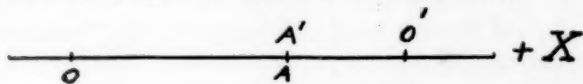
The following geometric constructions for addition, subtraction, multiplication and division of directed line segments, and the extraction of square roots of positive segments, are well known¹ but will be recalled here for the sake of completeness.

ADDITION AND SUBTRACTION OF DIRECTED LINE SEGMENTS



To add a number a' to a number a , we first construct two directed line-segments OA and $O'A'$ on a directed line X , such that the measures of OA and $O'A'$ are equal to the numbers a and a' , respectively. We then place the origin O' of $O'A'$ upon the terminus A of OA . The directed line-segment OA' , which joins the origin of the first segment to the terminus of the second, will have $a+a'$ as its measure.

In the figure, $O'A'$ is negative and numerically greater than OA , so that the sum $OA' = OA + O'A'$ is negative.



To subtract a number a' (subtrahend) from a number a (minuend) we first construct two directed line-segments OA and $O'A'$ on a directed line X , such that the measure of OA and $O'A'$ are equal to a and a' , respectively. We then place the termini

¹ Wilczynski and Slaughter, *College Algebra*, Allyn and Bacon, 1916, pp. 14, 15, 24, 25.

of these two segments so that they coincide. *The directed line-segment OO' , which joins the origin of the minuend to the origin of the subtrahend, will represent the difference $a - a'$ in magnitude and sign.*

In the figure $O'A'$ is negative and OA is positive, so that OO' is positive and in magnitude greater than OA .

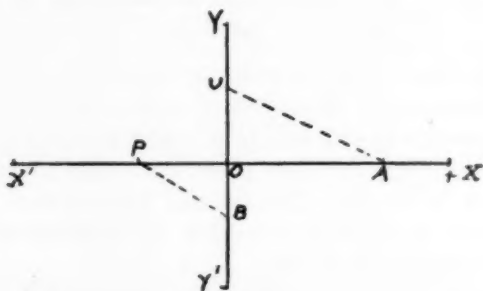
These constructions lead immediately to the following results:

1. The addition of a negative number is equivalent to the subtraction of a positive number of the same absolute value: $a + (-b) = a - b$.

2. The subtraction of a negative number is equivalent to the addition of a positive number of the same absolute value: $a - (-b) = a + b$.

MULTIPLICATION AND DIVISION OF DIRECTED LINE SEGMENTS

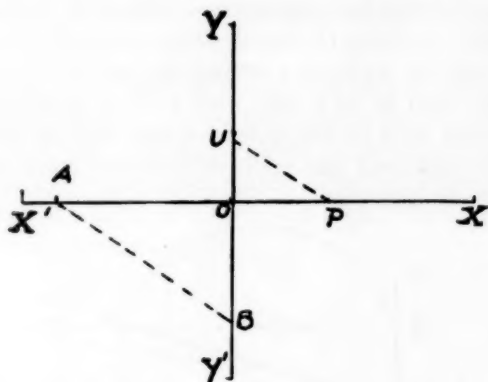
Take two directed line-segments $X'X$ and $Y'Y$, perpendicular to each other at O . Let OA and OB be directed line segments having measures a and b , respectively. Let OU be $+1$ and join U to A . Through B draw a parallel to AU and let P be the point in which this line intersects $X'X$. Then OP represents the product ab , in both magnitude and sign.



On XX' lay off the directed line-segment $OA = a$ units, and on YY' lay off the directed line-segment $OB = b$ units. Join A to B and through U draw a parallel to AB , intersecting $X'X$ in P . Then $OP = a/b$ in both magnitude and sign.

It is to be noted that the lines $X'X$ and $Y'Y$ could have been taken obliquely instead of at right angles. Furthermore, the units on each of these lines could have been chosen unequal to each other and the above constructions for the product and the quotient would still be correct. This is because the validity of

these constructions depends only on the properties of similar triangles.



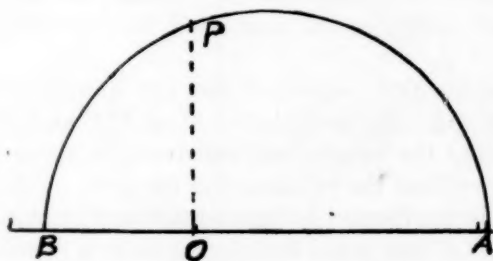
These constructions bring out clearly that the product of a number a by a number less than unity is less than a in magnitude; and that the quotient of a number a divided by a number less than unity is, in magnitude, greater than a .

Further, the division construction brings out the impossibility of division by zero, as in this case the line UP would be parallel to $X'X$.

Finally, these constructions can be used to illustrate the law of signs for multiplication and division, as well as the relations $a \times 0 = 0$, $0/a = 0$.

THE SQUARE ROOT CONSTRUCTION

In the accompanying figure $OA = a$ and $OB = b$ are line-segments. Then the semicircle with BA as diameter will

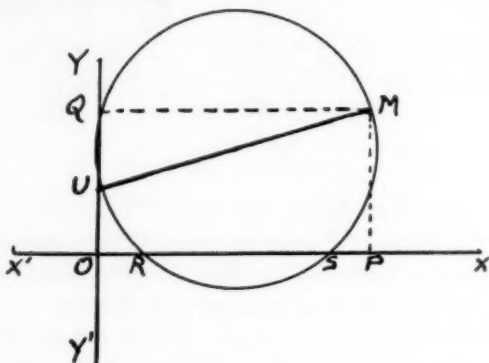


meet a perpendicular through O at a point P . The segment OP represents \sqrt{ab} . In particular, if $OB = 1$ unit, then $OP = \sqrt{a}$.

As a generalization of this construction it is of interest to

note the following construction² for the roots of a quadratic equation $x^2 - px + q = 0$.

Take two directed line-segments $X'X$ and $Y'Y$ perpendicular to each other at O , with equal units on both lines. Lay off $OP = p$ and $OQ = q$, and erect perpendiculars at P and Q , intersecting at M . Join M to U and with UM as diameter construct a circle cutting $X'X$ in the points R and S . The segments OR and OS will represent the roots of the quadratic equation in both magnitude and sign.



In order to prove the validity of this construction, we note that $OR \times OS = OU \times OQ$, from the property of the secants to a circle. But $OU = 1$, and $OQ = q$, so that $OR \times OS = q$. Also, $OR + OS = OR + RP$, since $OR = SP$, and hence $OR + OS = p$. We see then that OR and OS are two numbers having the product q (constant term of the quadratic), and a sum p (coefficient of the linear term with sign changed), so that OR and OS represent the roots of the quadratic.

From this construction one may obtain the usual relations between the nature of the roots and the discriminant of the quadratic.

When the quadratic equation has the special form $x^2 - a = 0$ the point M will fall a units below O on $Y'Y$ and the construction reduces to the square root construction given above.

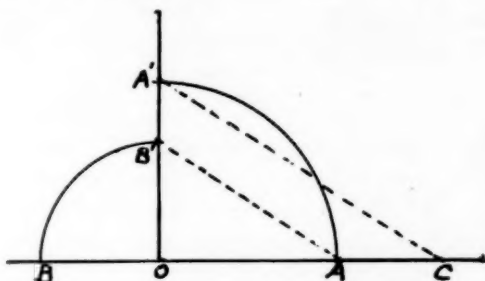
We see then that the construction for $a+b$, $a-b$, ab , a/b and \sqrt{a} can all be performed by using ruler and compasses. Hence, if a, b, c, d, \dots , are given line-segments, it is possible to find a ruler and compass construction for any line-segment which can be obtained from a, b, c, d, \dots , by a finite number of additions,

² Dickson, *First Course in the Theory of Equations*, John Wiley and Sons, 1922, pp. 29-30.

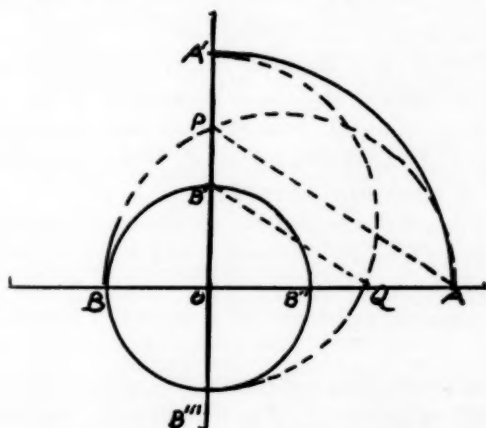
subtractions, multiplications, divisions and extractions of square roots.

GEOMETRIC PROPERTIES OF FIGURES ARISING FROM ALGEBRAIC IDENTITIES

Four examples will now be given to illustrate how simple algebraic identities lead to interesting properties of configurations consisting of straight lines and arcs of circles. The number of examples may be multiplied indefinitely by selecting other algebraic identities each of which will lead to a definite property of the resulting configuration.



Example 1. $\sqrt{a^2} = a$. Let B , O and A be any three points taken in the order shown in the figure. Draw the arcs AA' and BB' . Then the line $A'C$ parallel to $B'A$, will determine a point C , such that the circle with BC as diameter, passes through A' .



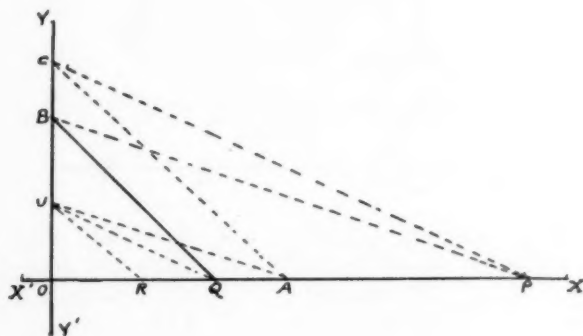
For, by the construction for the product of two numbers, $OC = a^2$ (OB' , though an arbitrary segment, may be considered as the unit). By the square root construction OA' is the square

root of a^2 , so that the fact that the semicircle determined by BC also passes through A' , is merely the geometrical property arising from the algebraic identity $\sqrt{a^2} = a$.

Example 2. $\sqrt{a}\sqrt{a} = a$. Take the points B, O, A as in the figure. Draw the arc AA' and the circle BB'' . With BA as diameter construct a semicircle, thus determining P , and with $A'B''$ as diameter construct a semicircle determining the point Q . Then the line through P , parallel to $B'Q$ will pass through the point A .

For, it is clear that $OP = \sqrt{a}$, $OQ = \sqrt{a}$ and the line through P , parallel to $B'Q$ will determine the product $\sqrt{a}\sqrt{a}$ and must therefore pass through A .

Example 3. $(ab)/c = (a/c)b$



Let U, B, C , be any three points on $Y'OY$ and A any point on $X'OX$. Join U to A , and through B draw a parallel to UA , thus determining P . Join P to C and through U draw a parallel to CP , thus determining Q . Join A to C and through U draw a parallel to CA , thus determining R . Then the line through B parallel to UR must pass through Q .

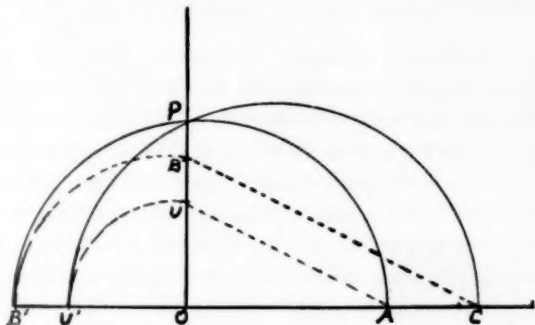
For, if $OA = a$, $OB = b$, and $OC = c$ (measured in terms of the unit OU), then $OP = ab$, $OQ = ab/c$, $OR = a/c$, and $(a/c)b$ must therefore be OQ .

For this example the lines $X'OX$ and $Y'OY$ need not be perpendicular.

Some other interesting constructions arise from the identities $(ab)^2 = a^2b^2$ and $\sqrt{a/b} = \sqrt{a}/\sqrt{b}$. Finally, the fundamental laws of algebra, for example, the associative law of multiplication, would yield very instructive geometrical results.

As an illustration of how a very trivial change in the form of

an expression leads to an interesting geometrical construction, the following example is given.



Example 4. $\sqrt{ab} = \sqrt{(ab)} \cdot 1$.

Let OA and OB be arbitrary segments on perpendicular lines. Lay off any other segment OU ; draw the arcs UU' and BB' . Join U to A and through B draw a parallel to UA , thus determining the point C . The semicircles with AB' and CU' as diameters will meet on the perpendicular through O .

For, $OC = ab$ and the intersection of the semicircle through C and U' (OP in the figure) is $\sqrt{(ab)} \cdot 1$. Similarly, OP is also \sqrt{ab} .

SCIENCE, GEOGRAPHY, BLENDED AT WESTERN WORLD'S FAIR

Development of modern science from its primitive roots will be dramatized in terms of geography in the Hall of Science on Treasure Island, site of the Golden Gate International Exposition in 1939, according to Milton Silverman, director of scientific exhibits.

Thirty of America's outstanding research laboratories, including the Mayo Clinic, the American Medical Association, and ranking universities from Harvard to Stanford, will present a graphic picture of the latest advancements in medicine and its related fields. This picture will carry the visitor to the beginning of history, and to the earth's four corners.

The story of quinine, for example, will be told in terms of a sluggish stream beyond the headwaters of the Amazon, called by ancient Peruvian Indians the "River of Bitter Water." Colonizing Spaniards in 1632 found in the river one of history's greatest medical discoveries.

Indians had drunk of the bitter waters to combat their malaria. More, they had discovered that the bitterness came from bark of the cinchona tree, and had taken to chewing the bark. Accepting their discoveries, the Spaniards discovered the medicinal value of quinine, which is found in the bark of the cinchona—and a specific remedy was known to science.

Similarly, other scientific highlights will be traced back to their geographical and historical roots.

WHAT MAY BE LEARNED FROM STUMPS*

BY E. L. MOSELEY

State Normal College, Bowling Green, Ohio

The dead bodies of animals and plants are less attractive than the living ones; nevertheless, some of them can be made very interesting. It is easy to interest a class in a snail shell, the cast-off skin of snake, the skull of a cat or woodchuck; it should not be difficult to interest them in stumps. These afford resting and feeding places for squirrels and chipmunks as well as for people, and they are fed upon by various kinds of insects and saprophytic fungi, some of which are beautiful. Moreover, for the inquiring mind the stump furnishes an intellectual feast. A class in nature study may well pause when it runs across a large stump.

How was the tree cut down? Which way did it fall? Why did it fall that way? Did it injure other trees when it fell? What uses may have been made of the trunk? About how long ago was it cut? Was it dead before that? Reasonable answers can be given to these questions without aid from a book or from a person who ever saw the tree when it was standing. The time of cutting can be estimated roughly by observing the condition of the bark and wood, whether the bark is still tight, whether fungi have made much growth on the wood, whether there are fresh looking chips around the stump, and whether the tree top still retains most of its leaves and whether these are full grown. If the time of observation is late summer or early fall and there are evidences that the tree was cut quite recently, yet its top is almost leafless, the student may infer that the tree was dead or dying before it was cut down and that this may have been one of the reasons for cutting it. If the top has been cleared away, the direction of fall may be inferred from the low part of the cut surface of the stump where the men chopped into the tree on one side before they started to saw at a higher level on the other side.

Students may observe on the stump the marks where wedges were driven in. Why was this done? They may notice places where the wood was scorched, showing that the men worked fast enough to keep themselves warm and to make the saw hot by friction. They should observe the straight lines left by the saw in running across, because these will make trouble in count-

* Read at the Indianapolis meeting of the American Nature Study Society, December 27, 1937.

ing the rings of growth if one undertakes to count where rings and saw marks are approximately parallel.

Observations on the wood should be accompanied by some instruction regarding the functions of its parts. The sapwood of most trees is easily distinguished from the heart wood. The numerous pores show where the saw cut across the tracheae. In trees like oak, ash, and locust large pores are mostly in the inner part of each annual ring and make the rings more conspicuous than in diffuse-porous wood like maple, box elder, beech and basswood. Pith rays are quite distinct without a lens on oak and sycamore stumps. If the kind of tree cannot be made out from what remains of its top or by looking at the bark or wood of the stump, it would probably require considerable work with a key for the identification of woods, and more time than could be spared by a class while in the woods. However, failure to identify does not prevent learning by observation and reflection interesting facts about the life of the tree.

About how old was it? In what part of its life did it grow fastest? Many stumps show that after the tree had been growing slowly during most of its early life it suddenly started to grow faster and continued to do so for a long time. This may have been due to the death of a large tree which had stood so near as to shut out the light.

Observe a stump in the edge of a woods or in a field and make out by inspecting its rings the approximate time of felling the trees which once shaded it. Find a fresh stump well within the woods and not far from old rotten stumps. Does the fresh stump show by increased width of the outer rings the effect of cutting the neighboring trees?

A tree produces a new ring each year by forming new wood just inside the bark. If we know when the tree died, we can find the date of formation of any particular ring on the stump provided that we can count without making an error all the rings between that one and the bark. In arid regions in the Southwest trees sometimes get so little moisture in the course of a year that they fail to form a distinct ring. This probably never occurs east of the 100th meridian. Very rarely do any trees in this region form more than one ring in a year. When a long summer drought arrests growth and heavy rains in September awaken new life some trees have been known to blossom in the fall. If a ring is so narrow and close to its neighbor as to cause doubt as to whether it represents a year's growth, it should be traced around far

enough to find out if it is distinct on some other part of the stump.

A solitary tree standing where the soil is deep and rich increases its diameter much faster than a tree of the same kind in the woods. White oaks in the woods grow slowly. When about two feet in diameter they usually show between 120 and 200 rings; most of those farther north than Indianapolis have more than 150 rings. Yet in northern Ohio I found a white oak stump 23 inches in diameter with only 53 rings. The tree had grown in an open level field where black sand covered clay to a depth of 14 to 18 inches, and the water table, even in a dry summer, was only a few feet below the surface. Trees that start growth in the woods must compete in early life with herbs and other low vegetation as well as with other trees. For more than half a century their growth is much impeded by larger trees, which not only shade them but also take moisture which otherwise their roots could absorb.

In the arid climate of the southwestern states trees are scattered and the dominant factor in their growth is the amount of rain. This is not true farther east; nevertheless, the amount of rain affects the width of the ring. If a certain ring is narrower than those on each side, it is evidence that there was less rain that year; if it is wider, there was more rain. This applies also to a group of five or any other small number of rings.

Trees growing on flood plains or near the bottom of valleys of perennial streams show less effect of dry seasons than those on slopes, at a higher level in fact they may suffer in a rainy season from water covering their roots too long. On slopes having a thin covering of soil the effect of drought is likely to be pronounced. In such situations the thickness of each annual ring depends largely on the amount of rain that falls in June, July, and August.

In order to find out what sort of response a tree made to variations in rainfall, one should keep in mind certain years which were outstanding for deficient or excessive rain. Since no two localities are just alike, complete conformity is not to be expected.

Over much of the region between the Rocky Mountains and the Atlantic Ocean the following years were dry, at least in the growing season; you will recall some of them: 1936, 1934, 1930, 1901, 1895, 1894. Some periods that were wet over large areas were: 1937, 1926-'29, 1880-'83, 1876, 1857-'59, 1852, 1846-'50.

In the Ohio Valley 1912-'13 were wet; in the region of the Great Lakes and upper Mississippi, 1903-'05.

If you can locate with certainty the rings of wood which correspond to these periods, you can determine whether the summer rains at the place where the tree grew were deficient or excessive at the same times as given above. Since the rate of growth depends on other things besides rainfall, more than one stump must be examined in order to draw satisfactory conclusions.

You may be interested in some of the conclusions I have drawn from a study of the rings on about 350 stumps and logs of trees that grew in nine states, but mostly in Ohio, Michigan, Indiana, and Tennessee. I hope that some of you will examine the rings on enough stumps to enable you to judge whether they do or do not bear out these conclusions. In either case I would be glad to learn of the results.

On each stump I find the ring that was formed in the year 1890 and set a pin on its outer border. I then count 45 rings toward the center and set another pin, and so on as far as I can go. This marks out zones of 45 years each, with a central core whose rings are also counted, and an outer zone which will have 45 rings if the ring next to the bark was formed in 1935. I measure the thickness of each zone, in case of the outer zone measuring only to the outside of the ring formed in 1935. If the tree was cut before, or early in 1935, the thickness of rings is computed from the part actually present. Likewise in the circle within the innermost pin, if there are twenty or more rings, the thickness of these affords means of judging the rate of growth at that time. We must bear in mind that a majority of trees starting to grow in the woods grow slowly for many years because of reasons that have been given. As to decline of growth rate in old age it is difficult to speak with definiteness. My measurement of numerous white oak stumps in southern Michigan and northern Ohio lead me to think that there is not much decline due to age until the tree is considerably more than 200 years old. This appears to be true also of bur oaks and American elms.

In the part of Ohio where I live extensive clearing of the land was delayed by the lack of natural drainage until after 1880, so that those trees which were not cut until recently were standing in almost virgin forest until toward the end of the nineteenth century. Consequently the benefit they received from the cutting

down of trees that had been shading them did not start much before 1890 and so the increase in growth rate produced in this way affected the last 45 year period much more than the preceding periods.

For convenience let us call the 45 years which began in 1891, period No. 1; the preceding 45 years, period No. 2, etc. We cannot well number them in the order of the time of their formation for the trees began their growth at different times. Where growth in period No. 1, was not favored more than in No. 2 by the cutting of other trees we find in a great majority of stumps more growth in period No. 2. This is what we would expect, because records of rainfall have been kept at some places ever since 1845 and nearly as long at quite a number of other places; in general they show that the period, 1846-1890, was characterized by more rain than the following period, although it included some dry years and many when the rainfall was near the average. West of the Alleghenies the records of rainfall prior to 1835 are very scanty, and those prior to 1845 are not numerous, so that early records afford scarcely any help in telling whether the first third of the nineteenth century was wet or dry. They do show that for several years prior to 1846 there was less rain than for several of the following years. My study of stumps shows that period No. 3, 1801-1845, was drier than No. 2, 1846-1890. It was also drier than No. 4, 1756-1800. Thus we have an alternation of wet and dry periods and are now at the beginning of another wet period of 45 years.

What about still earlier periods? Is each even-numbered period wet, each odd-numbered period dry?

Period 6, is clearly wet. For quite a while I had found so few trees that were old enough to cover the 7th period that I did not feel sure about it, but now I have examined stumps or logs of about 46 trees showing all or a part of the 7th period. I am convinced that it was dry. I have considerable evidence that the 8th period was wet, some evidence that the 9th was dry, and as yet very scanty evidence that the 10th was wet.

A large number of the stumps examined show the 5th period, but they do not show that it was dry. Professor A. E. Douglass of the University of Arizona, has worked out the sequences of wet and dry years in that part of the country so well that he is able to date timbers used in the construction of Indian pueblos which have been in ruins for centuries. He finds that some of his cycles fail early in the eighteenth century, which is the time of

my period No. 5. For many years then no spots were visible on the sun. Since that there has been no long period when the sun was free from visible spots.

Our rains, as well as other features of weather, depend upon the sun, although we do not yet fully understand how the changes in solar radiation affect precipitation, temperature, magnetism, auroras, and radio reception.

Forty-five years is double the magnetic sunspot period, which in turn is double the average interval from one sunspot minimum to the next.

Since the 45-year periods are alternately wet and dry, 90 years carries us from the beginning of one wet period to the beginning of the next, or from any part of any period to the corresponding part of the next similar period. As a basis for predictions 90 years works better than 45 or $22\frac{1}{2}$, although these are of some use. I have found also that it works better than 92 years which has been proposed, that is, it gives a better correlation between years of excessive rain, whether we take tree rings as evidence of the amount of rain, or river floods, Great Lake levels, or records of actual measurements of precipitation.

If you will date the rings carefully on several large stumps you will probably find that on a majority of them the rings formed in the first five or seven years following 1845 were wider than the average, also that this is true of the rings formed 90 years earlier, i.e., 1756-1762. Ninety years ago, 1847, Cincinnati had the greatest rainfall in its entire record of over a hundred years. You all know what happened there and elsewhere along the Ohio River in the early part of 1937. Most of the years 1846-1852, were years of excessive rainfall in those places whose record goes back that far in Ohio, Kentucky, Iowa, and other states from eastern Texas and Kansas to western Pennsylvania. In the record of floods at Pittsburgh none are given as occurring between 1852 and 1858, but there were six in the seven years 1846-1852. Ninety years later we have already had two floods. In view of the fact that all of the seven floods recorded at Pittsburgh from 1762 to 1832 were followed by floods after a period of about 90 years, what is the likelihood of more floods in the near future?

*When you change address be sure to notify Business Manager
W. F. Roecker, 3319 N. 14th Street, Milwaukee, Wis.*

CHANGING CONCEPTION OF TEACHING HELPS IN HIGH-SCHOOL CHEMISTRY TEXTBOOKS

BY RALPH E. DUNBAR

North Dakota Agricultural College, Fargo, N. D.

Educational progress and improved methods of teaching should be reflected in the type and amount of teaching helps included in representative high-school chemistry textbooks published over a period of several years. The present study was undertaken to determine what teaching helps show a noticeable variation as to occurrence; what teaching helps have remained constant as to occurrence; and what teaching helps have noticeably increased or decreased as to occurrence in recent years. Simmons¹ reports a similar investigation of sixteen general science textbooks, published over a period of twenty-four years. For ease of interpretation, the twenty-four years covered in this previous study were divided into four equal periods. General science textbooks of four publishers were used for each period. A tabulation was made of sixteen distinct types of teaching helps revealing the different types of aids for each period, as well as indicating the total frequency of occurrence for all periods.

In the present study a tabulation has been made of twenty-five representative high-school chemistry textbooks, so selected that the copyright date for one only occurs during each of the past twenty-five years, 1913 to 1937 inclusive. Obviously, by such a plan, it has been impossible to include many leading texts of these several years, since only one was selected for each year, and frequently several books were copyrighted during the same year. Likewise, later editions of many of these textbooks have since been published, but these older editions have been included as being representative of the several years involved. No chemistry textbook by any author or combination of authors has been included more than once in this investigation, regardless of the number of copyrights or editions involved. The following twenty-five chemistry textbooks, designed primarily for high-school use, have been included in this study.

Kahlenberg, Louis, and Hart, Edwin B., *Chemistry and Its Relations to Daily Life*, The Macmillan Company, New York City (1913).
Blanchard, Arthur A., and Wade, Frank B., *Foundations of Chemistry*, American Book Co., New York City (1914).

¹ Simmons, Maitland P., "Changing Conceptions of Teaching Helps in General Science Textbooks," *Science Education*, 20, 211-14 (1936).

- Irwin, Frederick C., Rivett, Byron J., and Tatlock, Orett, *Elementary and Applied Chemistry*, Row, Peterson and Company, New York City (1915).
- Tottingham, William Edward, and Ince, Joseph Waite, *Chemistry of the Farm and Home*, Webb Publishing Co., St. Paul, Minn. (1916).
- Snell, John Ferguson, *Elementary Household Chemistry*, The Macmillan Company, New York City (1917).
- Dull, Charles E., *Essentials of Modern Chemistry*, Henry Holt and Company, New York City (1918).
- Smith, Alexander, *Intermediate Text Book of Chemistry*, The Century Co., New York City (1919).
- Black, N. Henry, and Conant, James Bryant, *Practical Chemistry*, The Macmillan Company, New York City (1920).
- Willaman, John J., *Vocational Chemistry for Students of Agriculture and Home Economics*, J. B. Lippincott Company, Philadelphia, Pa. (1921).
- Newell, Lyman C., *Practical Chemistry*, D. C. Heath & Co., New York City (1922).
- Cook, Charles Gilpin, *Chemistry in Everyday Life*, D. Appleton and Company, New York City (1923).
- Gray, Carl William, Sandifur, Claude W., and Hanna, Howard J., *Fundamentals of Chemistry*, Houghton Mifflin Company, New York City (1924).
- Dinsmore, Ernest L., *Chemistry for Secondary Schools*, F. M. Ambrose Company, New York City (1925).
- Vivian, Alfred, *Everyday Chemistry*, American Book Company, New York City (1926).
- Holmes, Harry N., and Mattern, Louis W., *Elements of Chemistry*, The Macmillan Company, New York City (1927).
- Emery, Frederic B., Downey, Elzy F., Davis, Roscoe E., and Boynton, Charles E., *Chemistry in Everyday Life*, Lyons and Carnahan, New York City (1928).
- Fletcher, Gustav L., Smith, Herbert O., and Harrow, Benjamin, *Beginning Chemistry*, American Book Company, New York City (1929).
- McPherson, William, Henderson, William Edwards, and Fowler, George Winegan, *Chemistry for Today*, Ginn and Company, New York City (1930).
- Hessler, John C., *The First Year of Chemistry*, Benj. H. Sanborn & Co., New York City (1931).
- Timm, John Arrend, *An Introduction to Chemistry, A Pandemic Text*, McGraw-Hill Book Company, Inc., New York City (1932).
- Bruce, George Howard, *High School Chemistry*, World Book Company, Yonkers-on-Hudson, New York (1933).
- Bradbury, Robert H., *A First Book in Chemistry*, D. Appleton-Century Company, Inc., New York City (1934).
- Jaffe, Bernard, *New World of Chemistry*, Silver, Burdett and Company, New York City (1935).
- Biddle, Harry C., and Bush, George L., *Dynamic Chemistry*, Rand McNally & Company, New York City (1936).
- Brownlee, Raymond B., Fuller, Robert W., Hancock, William J., Sohon, Michael D., and Whitsit, Jesse E., *First Principles of Chemistry*, Allyn and Bacon, New York City (1937).

These twenty-five high-school chemistry textbooks are the product of twenty separate and distinct publishers and are believed to be a representative sampling of the average texts

of the past twenty-five years. From a careful examination of the same, a tabulation has been made of twenty-eight distinct types of teaching helps. This information has been arranged in the order of frequency in Table I.

TABLE I
TEACHING HELPS OCCURRING IN HIGH-SCHOOL CHEMISTRY TEXTBOOKS

Author of Textbook	Kahlenberg-Hart	Blanchard-Wade	Irwin et al	Tottingham-Ince	Snell	Dull	Smith	Black-Conant	Williaman	Newell	Cook	Gray et al	Dinamore	Vivian	Holmes-Mattern	Emery et al	Fletcher et al	McPherson et al	Hessler	Timm	Bruce	Bradbury	Jaffe	Biddle-Bush	Brownlee et al	Total Frequency
Copyright Date	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	
TEACHING HELPS																										
1. Pictures.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	25
2. Tables.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	25
3. Topic Surveys.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	25
4. Key Words.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	25
5. Key Statements...	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	25
6. Demonstrations...	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	24
7. Exercises.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	24
8. Questions.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23
9. Problems.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	22
10. Appendix.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	22
11. Footnotes.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	19
12. Atomic Weight Table in Cover...	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	18
13. Graphs.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
14. Summaries.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
15. Large and Small Type in Text.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
16. References.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	10
17. Review Suggestions.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	9
18. Experiments.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	9
19. Glossaries.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	6
20. Metric Units in Cover.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	4
21. Projects.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	3
22. Spectra in Cover...	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	3
23. Periodic Table in Cover.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2
24. Solubilities in Cover	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2
25. Valence Table in Cover.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2
26. Tests.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1
27. Electrochemical Series in Cover.....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1
28. Physical Constants of Gases in Cover...	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1

A very common and consistent practice in the preparation of high-school chemistry textbooks is the inclusion of valuable

reference material, usually in tabulated form, in an Appendix near the end of the book. In fact, the frequency and variation

TABLE II
TEACHING HELPS OCCURRING IN APPENDICES AND SIMILAR PAGES

Author of Textbook	Kahlenberg-Hart	Blanchard-Wade	Irwin et al	Tottingham-Ince	Snell	Dull	Smith	Black-Conant	Willaman	Newell	Cook*	Gray et al	Dinsmore	Vivian	Holmes-Mattern	Emery et al	Fletcher et al	McPherson et al	Hessler	Timm	Bruce	Bradbury	Jaffe	Biddle-Bush*	Brownlee et al	Total Frequency
Copyright Date	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	
1. The Metric System.		x	x		x	x	x		x	x	x				x			x	x	x	x	x	x	x		17
2. Vapor Pressure																										
Water.....		x	x				x	x		x			x		x	x		x	x	x	x	x	x	x		15
3. Solubility of Solids..		x	x				x	x				x	x		x	x		x	x	x	x	x	x	x		14
4. Physical Constants																										
of Elements.....		x	x				x					x	x			x	x	x	x		x	x	x	x		13
5. Physical Constants																										
of Gases.....		x						x		x			x		x	x		x	x	x	x	x	x	x		11
6. Bibliography.....				x			x		x	x					x	x		x	x	x	x	x	x	x		11
7. Thermometer Scales							x			x								x	x	x						9
8. Atomic Weight																										
Tables.....			x	x							x		x				x					x	x			8
9. Gas Laws.....																										6
10. Composition of		x													x											
Foods.....						x																				5
11. Physical Constants																										
of Compounds.....		x	x													x										4
12. E.M.F. Series-																										
Metals.....			x					x										x								4
13. Solubility of Gases.									x							x										4
14. Glossary.....																										4
15. Composition-Alloys.																										4
16. Apparatus and																										
Chemical Lists.....		x				x				x				x												4
17. Valence of Elements			x																							3
18. Mathematical Aids.																										3
19. Important Temper-																										
atures.....		x																								3
20. Scale of Hardness..								x								x										3
21. General Rules for																										
Solubility.....																										3
22. Names of Common																										
Chemicals.....																										3
23. Correction of Bar-																										
ometer Readings...			x																							3
24. Heats of Formation																										2
25. Nobel Prize Winners																										2
26. Logarithms.....		x																								2
27. Number of Miscel-																										
laneous Items Ap-																										
pearing but Once...	2	2	7			1		1					4		3	4	2		1	1			1	2	31	

* No "Appendix" designated specifically as such but the textbook contains corresponding pages devoted to similar tabulated material.

of this type of material in twenty-two of the twenty-five textbooks studied made it seem advisable to make a more detailed study of this type of material. In two more of the twenty-five textbooks such tabulated data was assembled on extra pages near the end of the book without being specifically designated as an "Appendix." Thus a total of twenty-four out of the twenty-five texts contain valuable reference material for teacher and student use, assembled in a separate Appendix or its equivalent, near the end of the book. This practice is surely to be commended, and the amount and frequency of such material has remained surprisingly consistent throughout the twenty-five years. A tabulation of this type of material is included in Table II. This tabulation includes both that type of reference material listed under the title of "Appendix" and also similar material included in extra pages outside the main body of the two additional texts. The wide variation in the nature of a portion of this material makes certain condensations in this tabulation advisable for brevity's sake. For instance, there are thirty-one items that appear but once in all of the twenty-five texts included in this study. Rather than list each by complete title, such single items have been assembled under one heading as the final entry in Table II. The prevalence of atomic weight tables, periodic tables, and similar items included within the cover pages of the texts have been included under suitable headings in Table I only.

An examination of Table I indicates that pictures, tables, topic surveys, key words and key statements, each appearing with a frequency of twenty-five, have been used consistently during the past twenty-five years. Pictures offer a convenient and effective means of readily giving definite impressions. They offer one of our most practical teaching helps. Such pictures should be carefully selected and logically used. Line drawings of laboratory equipment, industrial photographs, portraits of chemists, and pictures of household appliances predominate. There has been a noticeable improvement in the quality and quantity of such illustrations in recent years. It has long been a common practice to assemble related items in tabulated form for brevity and purposes of comparison. Topic surveys aid in correlating facts of importance, and their common and continued use indicates something of their value. Key words and key statements help principally in organizing the material presented or in emphasizing important terms, laws and ideas.

Directions for demonstrations, either definitely outlined or sufficiently suggested for teacher's use, appear in twenty-four of the texts. Exercises, questions and problems for student use are closely related. They show a frequency of twenty-four, twenty-three, and twenty-two respectively. While the distribution over the past twenty-five years appears to be rather uniform, a more careful examination of the texts reveals a marked improvement in the quality, variety, and quantity of these teaching aids in recent years. Twenty-two of the twenty-five textbooks contain useful reference material, assembled in separate pages near the end of the book and designated specifically as an "Appendix." Two additional texts contain similar pages and material without specifically designating them as an "Appendix." A more detailed and complete tabulation of this material is given in Table II. Footnotes are used in nineteen instances to elaborate or qualify statements appearing in the main body of the text. The distribution is rather uniform over the twenty-five year period. However, their use and importance is not as great as their frequency would indicate since most authors use them very sparingly. Atomic weight tables appear in the covers of eighteen texts, with a very noticeable predominance in recent years. Some other books place this reference material in the Appendix. The cover page, considering the extensive use of this information, would seem to be the logical place for this table.

Graphs appear in sixteen textbooks. While there is but a slight increase in frequency of occurrence in recent years, yet the most recent texts contain a far greater number of such teaching helps than older books. The use of graphs appears to be very noticeably increasing in high-school chemistry textbooks in recent years. Summaries, which should be a valuable aid to students in organizing the contents of the several chapters, and with a frequency of fifteen, appear rather evenly distributed throughout the period of the past twenty-five years. However, recent texts have included far more comprehensive and useful summaries than most older books. Their use is definitely on the increase. The use of large and small type in the body of the text for purposes of emphasis has been a common practice for years, with some increase in frequency and amount in recent years. Total frequency is fifteen. An encouraging discovery was to find a far greater use of suggested readings and references in recent volumes. While the total frequency is but

ten, most of these appear in recent years and many of the latest textbooks contain splendid lists of suggested readings for student use. Review suggestions are usually used sparingly, if at all. The distribution of nine slightly favors recent years. However, one or two recent volumes contain splendid and comprehensive review suggestions. The frequency of experiments, namely nine, is very definitely on the decrease. There is a very noticeable tendency in later years to place experimental work for student use in separate laboratory manuals rather than in the text itself. This would logically explain this recent decrease in frequency.

The use of glossaries of chemical terms, with a total frequency of six, appears to be on the increase. The placing of metric unit tables in the cover of the textbooks has never been a very common practice. The frequency of four is rather uniformly distributed. Only three textbooks make specific project suggestions. Three recent texts contain spectra plates in their cover pages. Periodic tables, tables of solubility and valence tables, each contained within the cover pages, and each with a frequency of two, are variously scattered throughout the period covered in this study. The most recent textbook, included in this study, contains a comprehensive series of student tests. Other recent authors have supplied work books with test items. Whether this is a new and significant tendency, time only can tell. One recent volume also contains an electrochemical series chart, and a table of the important physical constants of some common gases in the cover pages.

Table II is practically self-explanatory. The variety of material included in the several appendices is extensive as indicated. Two of the textbooks, designated by asterisks, do not include an appendix, designated specifically as such, but contain corresponding pages devoted to similar tabulated material. The type and amount of this material has but slightly increased in recent years. Metric tables head the list in order of frequency, followed by vapor pressure tables, solubility of solids, physical constants of the elements, physical constants of gases, and bibliographies of suggested readings. Other topics follow in decreasing order of frequency as tabulated until a list of some thirty-one items occur, no one of which appears more than once in all of the textbooks studied. These single items have been grouped into one final entry, rather than listed as individual items. This seems to be justified for brevity, and also because

of the fact that these items are so numerous and varied as to lack general interest or importance.

CONCLUSIONS

In addition to the facts immediately obvious from a study of Tables I and II, the following conclusions seem to be justified.

1. Supplementary teaching helps, as tabulated in Table I, have consistently increased in quality and quantity in high-school chemistry textbooks during the past twenty-five years.

2. The items of exercises, questions, problems, graphs, summaries, references, and review suggestions, designed especially for student study and use, have increased noticeably during recent years in these representative textbooks.

3. Numerous other teaching helps, particularly those heading the list in Table I, run surprisingly uniform in these textbooks, published over a period of twenty-five years.

4. While Table I shows a consistent use of pictures over twenty-five years, yet there has been a marked and encouraging improvement in the quality and quantity of these illustrations.

5. Recent texts show a marked tendency to utilize the four pages within the covers for supplementary tables and reference material.

6. The inclusion of laboratory directions or experiments as an integral part of high-school chemistry textbooks is definitely on the decrease. Such material is now usually published in a separate laboratory manual.

7. Large amounts of statistical data are assembled in separate appendices. This practice has generally prevailed. While there is little if any change in the amount of such material included, there is some improvement in the quality and choice of such reference material in recent volumes.

8. The wide variation and lack of uniformity of the material in these appendices is particularly noticeable.

RUBBER-MAKING CHEMICAL

A new grade of magnesium carbonate, used in making translucent rubber products, has been developed by chemists as a step in both improving translucent rubber and lessening American dependence on foreign imports of the substance, it is announced.

Improvements in translucent rubber products manufactured with it are attributed by its discoverers, chemists of the Keasbey and Mattison Company, to the fact that it bends light rays to exactly the same degree as they are bent by translucent rubber. In technical language, the new crystalline substance has the same refractive index as rubber.

THE TEACHING OF FINANCIAL MATHEMATICS

BY MYRON O. TRIPP

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The application of mathematics to financial problems is one of the recent trends in collegiate instruction. The development of this type of work dates back only about a quarter of a century. At first it was referred to as the mathematics of investment, but in recent years the usual caption has been Mathematics of Finance.

With the stress laid upon business administration in American colleges during the last few decades, it has been natural for professors of mathematics to make their subjects more concrete by seeking out those applications to business which can be mastered by students with only an elementary knowledge of mathematical principles. An understanding of geometric series, logarithms, and the usual one and a half units of high school algebra suffices to give the student a fair working knowledge. In addition, if the student wishes to go on with life insurance, he needs fundamental work in the theory of probability. In this article, however, no attention will be given to this latter kind of training.

In the public schools it is commonly assumed that simple interest is a topic of great importance, and compound interest one of relatively little value. However, in collegiate instruction it is compound interest that must receive the greater stress, for this topic is fundamental in dealing with annuities, amortization of debts, sinking funds, depreciation and bond evaluations.

The object of this discussion is to show how the usual problems of finance may be solved by the use of a few elementary principles, thus avoiding the long list of formulae ordinarily given in the average treatise on the subject. In this plan of instruction it is true that frequently the solution is longer than by means of formulae, but it has the advantage of giving a better understanding of all the principles involved, and a feeling of independence in working over the subject. Then, too, the avoidance of the formulae tends to make the student less mechanical, something that is a decided pedagogical advantage.

The amount at simple interest is defined by the relation

$$A = P(1 + ni) \quad (1)$$

where A is the amount, P the principal, n the number of periods, and i the rate of interest per period. In ordinary business transactions, $n \leq 1$, since accrued interest is usually collected at the end of a fixed interval or portion of that interval.

The amount at compound interest is defined by the relation

$$A = P(1+i)^n \quad (2)$$

where A , P , n , and i have the same significance as in (1). If $n=1$, the two formulae (1) and (2) become identical, i.e., the amount at simple interest for a given period is the same as the amount at compound interest for the period.

In ordinary business affairs, the use of (2) implies $n \geq 1$. However, in the derivation of mathematical principles it is convenient sometimes to take $n < 1$. In this latter case the value of A from (2) is less than the value of A from (1), i.e., in compound interest for a part of a period, the amount is less than the amount at simple interest for that same part. The truth of this statement can be proved by expanding $(1+i)^n$, ($0 < n < 1$), by the binomial theorem and comparing it with $1+ni$. Since we take $i < 1$, the expansion of $(1+i)^n$ forms a convergent infinite series. Moreover, beginning with the third term, this expansion is an alternating series with decreasing terms, i.e., in absolute value; and since the third term is negative, the sum of this alternating series is negative. In other words,

$$(1+i)^n = 1+ni - (\text{a positive quantity}).$$

For $n \geq 1$, the third term in the expansion of $(1+i)^n$ will be positive. In this case, the convergent alternating series, considered beyond $(1+ni)$, may start with the third or some subsequent term. Hence we have

$$(1+i)^n = 1+ni + (\text{a positive quantity}),$$

that is, A as given by (2) is greater than A as given by (1). For the special case when $n=0$, i.e., the time = 0, $A=P$ from both (1) and (2). This is an interesting case corresponding to the principle in algebra that any number with a zero exponent may be taken equal to unity.

As a numerical illustration, let us take $P = \$1,000,000$, $i = .05$, and $n = \frac{1}{2}$; we find from (1), $A = \$1,025,000$, and from (2), $A = \$1,024,695$, that is, the difference between the amount at simple interest and the amount at compound interest is \$305.¹

¹ This illustration is taken from a very comprehensive treatise of over 1200 pages by Moore (J. H.), *Financial Mathematics*, p. 99, Prentice, Hall & Co., 1929, New York.

Consideration will now be given to a problem of considerable popular interest, namely, how long does it take a given sum of money, P_1 , at a given rate i_1 , to double at compound interest. That is, we seek to solve for n the transcendental equation

$$2P_1 = P_1(1+i_1)^n$$

Since $P_1 \neq 0$, our equation reduces to

$$2 = (1+i_1)^n,$$

which may be readily solved by logarithms, giving

$$n = \frac{.693}{i_1} + .35 \text{ (approx.)}^2$$

Another approximation which is easier to remember and to apply; but, in general, not so accurate is

$$n = \frac{.70}{i_1}$$

For $i_1 = .02$, the two approximations are the same.

Another problem closely related to the above and of especial interest at the present time is the determination of the rate earned by investing in U. S. Saving Bonds. We assume, as is usually the case with bonds, that interest is paid semi-annually, and converted into principal semi-annually. In formula (2) above, let i = the semi-annual rate of interest, $n = 20$. It is no loss of generality to take $P = \$75$, $A = \$100$. Hence equation (2) becomes

$$100 = 75(1+i)^{20}$$

This is an equation of the 20th degree and, accordingly, it is best solved by logarithms.

Hence

$$\log 100 = \log 75 + 20 \log(1+i)$$

Therefore

$$\log(1+i) = \frac{\log 100 - \log 75}{20}$$

From this $(1+i)$ can be easily determined. Hence the nominal rate of interest (the rate usually understood by the public), $2i$, is easily determined.

² Cf. Rietz, Crathorne and Rietz, *Mathematics of Finance*, p. 16, H. Holt and Co., 1932.

The most important problem in the study of elementary financial mathematics concerns itself with the investigation of annuities, that is, a series of equal payments made at equal periods of time. Two important cases arise: (1) How much money must be paid at the present time to obtain an annuity starting with the present time (ordinary annuity), or starting at some future time (deferred annuity), and running for a definite number of periods? (2) What will an annuity starting now and continuing for a certain number of periods amount to at the time the last payment is made?

As an illustration of the first case, let us find the cost at the present time of a deferred annuity when it is given that (a) the use of money has a value of 6% compounded quarterly, (b) 30 payments of \$100 each are to be made at the end of each quarter, (c) the first payment is to be made at the end of $3\frac{1}{4}$ years.

First it should be noted that the cost of an annuity is the sum of the present values of each of the 30 payments. Let x = the present value of the first payment. Then

$$x(1.015)^{13} = 100$$

from equation (2).

$$\therefore x = 100(1.015)^{-13}$$

In like manner we may get the present value of each of the other payments. Hence we have the geometric series

$$\begin{aligned} \text{Cost} &= 100(1.05)^{-13} + 100(1.015)^{-14} + \dots + 100(1.015)^{-42} \quad (\text{I}) \\ &= 100 [(1.05)^{-13} + (1.015)^{-14} + \dots + (1.015)^{-42}]. \end{aligned}$$

The sum of the series in the square brackets is

$$\frac{(1.015)^{-12} - (1.015)^{-42}}{.015}$$

The advantage of this over the usual plan of taking the difference of two series is that the student must be able to account for every payment and its present value. Naturally after the students can carry out easily a scheme such as the above the instructor should show a shorter process by subtracting the two series by the ordinary method.

It is helpful to use graphic methods by placing the payments on a straight horizontal line at distances from the left end equal to the times that payments are to be made. Hence the left end of the line indicates the present time. Therefore the terms at the

right in (I) above should be set down under the left end (present time).

The second case (amount of an annuity) can be graphed in a similar way; but then the accumulated payments must be set down under the right hand end of the line, since in this case we are dealing with a geometric series with positive exponents.

One of the most interesting applications of annuities is that of amortization, i.e., the extinction of debts by equal payments made at equal intervals. In order to make clear this process, let us consider a concrete problem.

A man mortgages his farm for \$8000 and wishes to pay off the debt, principal and interest, in 14 equal semi-annual payments, the rate of interest being 6% convertible semi-annually.

Let x = the required semi-annual payment. The sum of the present values of these 14 payments must equal \$8000. Hence our required equation in x must be

$$x(1.03)^{-1} + x(1.03)^{-2} + x(1.03)^{-3} + \dots + x(1.03)^{-14} = \$8000,$$

or

$$x[(1.03)^{-1} + (1.03)^{-2} + (1.03)^{-3} + \dots + (1.03)^{-14}] = \$8000.$$

The sum of the series in the square bracket may best be found by taking $a = (1.03)^{-14}$, $r = 1.03$, and $l = (1.03)^{-1}$. The coefficient of x can be easily obtained and accordingly the equation readily solved.

Instead of taking the present value of each payment, we may find the amount of each payment at the end of seven years and write our equation as follows:

$$x(1.03)^{13} + x(1.03)^{12} + x(1.03)^{11} + \dots + x(1.03) + x = \$8000(1.03)^{14},$$

or

$$x[(1.03)^{13} + (1.03)^{12} + (1.03)^{11} + \dots + (1.03) + 1] = \$8000(1.03)^{14}.$$

The last equation may be obtained by taking the equation of present values and multiplying each side by $(1.03)^{14}$. In fact we may compute the value of the debt (\$8000) for any date in the past (or future) and set the value equal to the amount of the payments at that date.

The interest payments, or coupons on bonds, are an annuity and when one wishes to buy a bond to secure a certain rate of investment it is necessary to find the cost, or present value of this annuity. For example, let us find the cost of a 6%, \$100

bond due in 10 years, interest paid semi-annually, bought to secure the investor an income of 4%. Here the cost of the bond equals the present value of the coupons plus the present value of the maturity value of the bond. In this case we have the equation,

Cost of bond =

$$3(1.02)^{-1} + 3(1.02)^{-2} + \dots + 3(1.02)^{-20} + 100(1.02)^{-20}.$$

A more practical problem in connection with bonds is that of determining the yield rate on a bond when the price of the bond and the coupon rate are given. This leads to the use of interpolation methods, which are of great value to the student, and should be thoroughly emphasized. It is just this kind of work that students do not like; but it is nevertheless extremely important as a method of thinking.

It is often asked why the instructors do not give the student a bond table and let him look up the answer quickly when dealing with problems such as the above. The reply is that collegiate or high school instruction is for the purpose of developing fundamental principles, so that, if especial cases come up not covered by the bond table, the student can work out his own solution. It is interesting, after students have solved a number of problems, to show that the final results in most cases can be read from tables or a nomographic chart.

The study of depreciation may be carried out along mathematical lines in a way that gives excellent drill in the fundamental principles of finance. In studying U. S. Saving Bonds, we took a sum of money and determined the rate of interest which will make that sum increase one third after a certain lapse of time. In depreciation by the constant percentage method we have a somewhat similar problem, where we take a certain value for a piece of property and determine at what rate per cent per period of time this property will decrease to a certain value after a certain time. For example, if a new automobile worth \$1200 depreciates each year at a constant percentage for four years, at which time it is worth \$350, what is the annual rate of depreciation?

Let r = the constant rate of depreciation. Then

$$\begin{aligned} 1200(1-r)^4 &= 350 \\ \therefore (1-r)^4 &= \frac{350}{1200} = \frac{7}{24}. \end{aligned}$$

This equation can easily be solved by taking logs. If we take

$$1200(1+r)^4 = 350$$

we would get a correct result, r being negative.

The subject of perpetuities and capitalization furnish a good example of the application of infinite geometric series. In every case the student should set up the infinite series, and then there is no trouble about the formulae which are so bewildering to the student. In Moore's treatise (cited above), under the chapter on perpetuities alone, there are listed twenty-four different formulae. Moreover the student who cannot set up the geometric series for the problem cannot be expected to derive the formula that applies to the problem. It is likewise difficult for the student to keep clearly in mind the exact meaning of all the symbolism involved in the numerous formulae of mathematical finance.

Let us solve the following problem in perpetuities. A wooden bridge costing \$8000 is to be replaced every 10 years by an equal expenditure. What sum should be set aside to provide for an infinite number of replacements if the interest rate is 4% compounded yearly? The amount to be set aside in a case of this kind is commonly referred to as the capitalized cost; it is the first cost plus the sum of the present values of future payments. Therefore
capitalized cost =

$$\begin{aligned} &\$8000 + 8000(1.04)^{-10} + 8000(1.04)^{-20} + 8000(1.04)^{-30} \dots = \\ &8000(1 + 1.04)^{-10} + (1.04)^{-20} + (1.04)^{-30} + \dots) \end{aligned}$$

Since the sum of an infinite geometric series with ratio < 1 is

$$s = \frac{a}{1-r}$$

we have, for the quantity in the parentheses, $a = 1$, $r = (1.04)^{-10}$. Hence

$$\text{capitalized cost} = 8000 \left(\frac{1}{1 - (1.04)^{-10}} \right)$$

With the recent rapid development in Junior Colleges, the question of what type of mathematics may be taught in these institutions is quite pertinent. Apparently the kind of mathematics outlined above is not too advanced, but the formulae

work as usually given in the average text should be omitted. It should be kept in mind that this application of mathematics cannot well be given by a lecture course; it is strictly a course in exercise work on the part of the student. Consequently, day by day the student must make proper applications of geometric series and logarithms, including necessary interpolations.

In the preparation of teachers for junior and senior high school work, a concrete course in mathematical finance is very helpful—especially is this true in business courses where the teacher is expected to discuss many of the fundamental ideas involved in the topics explained above. Certainly the prospective teacher of mathematics must develop some perspective in dealing with topics taken up by any class, and hence we must conclude that the mathematics of finance is a very essential vitalizing element for the high school teacher.

SOME SUGGESTIONS FOR PERFORMING EXPERIMENTS WITH THE MERCURY VACUUM PUMP

BY W. T. WILKS

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In the April issue of *SCHOOL SCIENCE AND MATHEMATICS* specifications were given for the construction of a mercury vacuum pump. This pump can be constructed at little cost, and in schools where there is an acute shortage of funds for laboratory equipment, it may serve satisfactorily as a substitute for the expensive lever action or rotary vacuum pump.

As is the case in many school constructed pieces of apparatus, the mercury vacuum pump has its disadvantages when contrasted with more expensive apparatus purchased from laboratory supply companies. The most obvious disadvantage of the mercury pump is its lack of an air pump base. Such a base costs about seven dollars and necessitates the use of bell jars which add to the cost. If the school is equipped for metal working an air pump base can be constructed, but the bell jars are still items of expense.

It is possible to do away with the base and bell jars entirely if the teacher will use a little ingenuity in conducting experiments with the mercury vacuum pump. The following six ex-

MERCURY VACUUM PUMP EXPERIMENTS

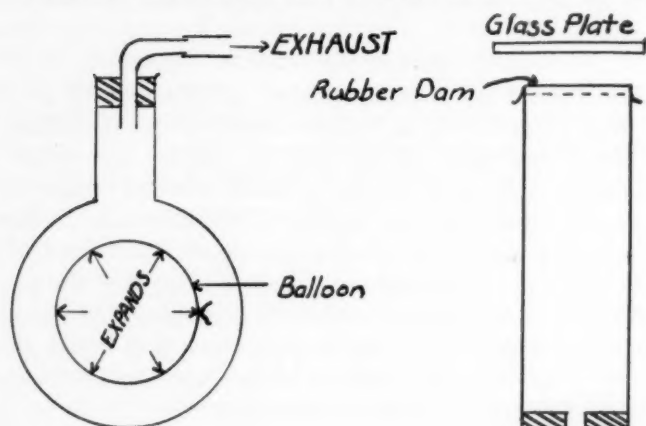


Fig. 1.

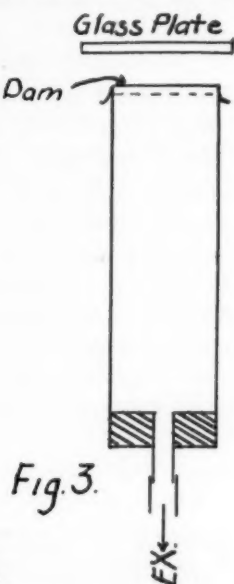


Fig. 3.

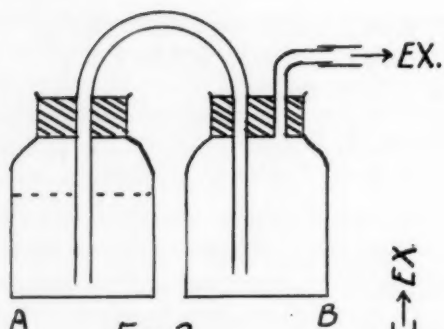


Fig. 2.

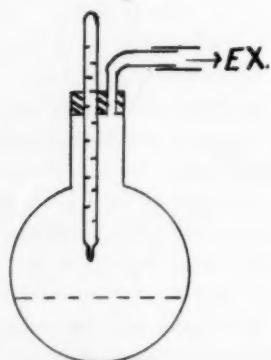


Fig. 6

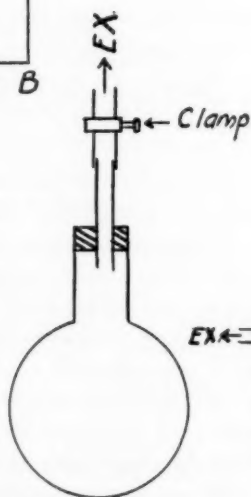


Fig. 4

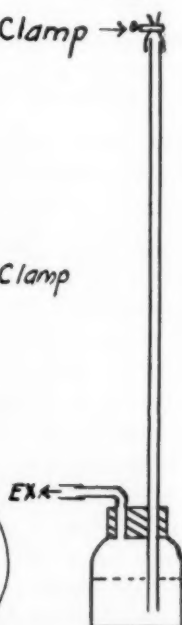


Fig. 5.

periments are given as examples of uses to which the pump can be placed by using material which is available in every science laboratory. Other, and perhaps better, experiments can be worked out by the teacher as the need arises.

To Show the Expansion of Air with Changes in Pressure (Fig. 1)—The opening of the uninflated balloon is tied tightly and the balloon is placed in the large flask. As air is exhausted from the flask the air in the balloon expands inflating the balloon to the size of the flask.

A variation of this experiment, to show air pressure, is to use a 2 hole stopper in the flask with a glass tube through the extra hole. Tie the balloon to the lower end of the glass tube and exhaust the flask. Air pressure through the tube will inflate the balloon.

To Show the Expansion of Air (Fig. 2)—Connect the wide mouth bottles with glass tubing as shown. Bottle *A* is partly filled with colored water. As the air is exhausted from bottle *B* the expansion of air in bottle *A* will force the water through the U tube. When air pressure is admitted again to bottle *B* the flow of water will be reversed.

To Show Air Pressure (Fig. 3)—A piece of rubber dam (a section cut from a balloon is a satisfactory substitute) is tied over the end of a student lamp chimney (or large glass tubing). When the chimney is exhausted, air pressure pushes the dam inward.

To show the dam is not "sucked" in, cover the dam with a glass plate coated with vacuum wax (or vaseline) and exhaust. The dam will not be pushed in until the plate is removed.

To Show That Air Has Weight (Fig. 4)—Exhaust the flask and close the clamp. Remove from the pump and counter-balance carefully on a laboratory balance. When the clamp is loosened air can be heard rushing into the flask and the flask will show an increase in weight.

To Show the Effect of Changes in Air Pressure on Liquids in Tubes (Fig. 5)—Arrange the tube in the wide mouth bottle as shown. Partly fill the jar with water. Suck the water up the tube with the mouth and close the clamp. Exhaust the bottle and note the effect on the height of the water in the tube.

To Show the Effect of Changes of Pressure on the Boiling Point of a Liquid (Fig. 6)—Arrange the apparatus as shown. First boil the water at normal atmospheric pressure and note the boiling point. Then exhaust the flask as it boils and note the effect on the boiling point.

CLEAN SOD OR WEEDY SOIL

BY RALPH C. BENEDICT

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The teaching of any biological topic is sometimes made more difficult by the preoccupation of the minds of pupils with earlier ideas. I recall vividly how through years of high school teaching, when the topic of photosynthesis came up, the minds of the children had been pre-empted: "Green plants breathe carbon dioxide; animals breathe oxygen." How thoroughly this false idea had been implanted! The fixity with which it was held always constituted a serious handicap to the development of the real facts. It was hard to displace by frontal attack, and it persisted even when an indirect approach was made. I wonder whether that bit of elementary school indoctrination still vexes the high school teacher? When clean pasture or meadow sod is ploughed under, it always has fewer weeds than soil which has been under cultivation previously.

In college teaching, at the present time, one item stands out year after year as a bit of misinformation which many students seem to have imbibed very thoroughly in their high school years. I sometimes test this by asking large lecture sections in the first term of college biology, "Who invented the microscope?" A chorus of voices always answers "Leeuwenhoek." There are other similar items, like the mythological figure of the plant breeder who outranks Mendel, DeVries, and Darwin, and will, I suppose, sometime come to stand with Ceres, but this topic does not come under my purview in the first semester's work.

Speaking of Leeuwenhoek, "Let's look at the record," as Al Smith was wont to say. There are a number of places where the record may be found. Encyclopaedia articles on the microscope are good general sources. Histories of biology, like those of Charles Singer, Locy, Nordenskiöld, and histories of physics, are better. Still better are some of the original articles, many of which are available in English, such as those of Roger Bacon, Leeuwenhoek, Galileo, Robert Hooke, and others.

Charles Singer says (*Story of Living Things*, Harpers) that Galileo was the first to use a compound microscope in the study of living things. It is said elsewhere that Galileo got his idea of lenses in series from the Jansens, father and son, of Holland. This first coupling of lenses is ascribed to the Jansens as of 1591, but possibly belongs still earlier to the Englishman, Digges,

in 1570. Singer says that Galileo's instrument could be used as a microscope when looked through from one end, and as a telescope when looked through from the other. Singer also records as follows: "An Englishman travelling in Italy in 1610 wrote that 'I heard Galileo himself narrate how he distinguished perfectly with his optic glass the organs of motion and of sense in the smaller animals.'"

In 1625, the first drawing of a living thing, made with the aid of a microscope, was published by Stelluti (Singer). In 1660, Malpighi observed and reported the capillary circulation of the blood in a frog's lung tissue, thus establishing a final link in confirmation of Harvey's description of circulation. In 1665, Robert Hooke, a brilliant English physicist, published his *Micrographia*, containing his famous drawing of cork cells, as a demonstration of the advantages of the compound microscopes. Leeuwenhoek's first report of a microscopic discovery is said to have been made in 1673. He himself wrote in the *Transactions* of the London Royal Society, where all his discoveries were reported, as follows: "In the year 1675, I discovered very small living creatures in rain water, which had stood but few days in a new earthen pot glazed blue within. This invited me to view this water with great attention especially those little animals appearing to me ten thousand times less than those represented by M. Swammerdam, and by him called water-fleas or water lice, which may be perceived in the water with the naked eye."

Where, then, does Leeuwenhoek come in? Here the record is explicit. It reports that the Dutch microscopist worked entirely with simple lenses, technically called simple microscopes, or in plain terms, magnifying glasses. Locy, whose account is the most circumstantial, is authority for the statement that Leeuwenhoek ground over four hundred and seventy separate lenses, each fitted into a frame, and each designed largely for the examination of a single kind of preparation. Some of them are reported as magnifying as much as 270 times! With these lenses, Leeuwenhoek was the first to report on many important microscope structures; blood corpuscles of various kinds, spermatozoa, protozoa, and even bacteria (1683).

But it will be realized, such single lens magnifying glasses were not the invention of Leeuwenhoek. Roger Bacon had used them when he made spectacles in the thirteenth century, and it is reported that lenses as magnifying agents had been

known in classical times in Egypt. Then, further, since Leeuwenhoek was born in 1632, he had been preceded over fifty years in the microscopic study of living things by Galileo and Stelluti. The three hundredth anniversary of his birth has recently been celebrated, and a very interesting memorial publication was issued.

While the Dutchman did not invent any microscope and was not the first to use it for biological study, his position in the history of biology is nonetheless secure. He seems to have been one of those men who act like ferments in stimulating others. Indefatigable in grinding his lenses and in using them to examine more and more objects and material, he was more than anyone else responsible for awakening men to the possibilities of microscopy. Furthermore, he developed the simple magnifying glass to its ultimate capacity. No one before or since has used a single lens as efficiently.

Leeuwenhoek was like the first man to set foot in some unexplored territory, who returns to tell of the diversity of marvels he has seen. Contemporaneous with him were three others who more intensely surveyed the new land: Malpighi, the Italian, Grew, the Englishman, who worked with plant tissues, and Swammerdam, another Dutchman, who made such careful studies of insect anatomy that his drawings are still authentic representations of structure. The remarkable thing about the work of these men of the 17th century is that their findings stood unsurpassed for one hundred and fifty years, until the nineteenth century, when further improvement of the microscope and the breaking away from stultifying philosophical theories gave rise to the movement from which the cell doctrine developed.

DR. TYLER TO HEAD DEPARTMENT OF EDUCATION

Dr. Ralph W. Tyler, professor of education, and research associate of the Bureau of Educational Research, Ohio State University, has been appointed professor and head of the department of education and chief examiner of the Board of Examinations of the University of Chicago. Dr. Tyler will come to the University October 1 of this year.

Professor Tyler, a Ph.D. of the University of Chicago, will succeed as head of the department of education the noted educator, Charles H. Judd, whose retirement is effective this June.

Although Dr. Tyler will not be 36 until April, he is highly regarded by professional educators. Trained in the natural sciences and also well equipped as a statistician and educational psychologist, his skill as an evaluator of educational methods has brought him particularly to the attention of secondary school and college authorities.

NATURE RECREATION OF THE WESTERN RESERVE

WRITTEN FOR NATIONAL RECREATION ASSOCIATION

BY WILLIAM GOULD VINAL

Massachusetts State College, Amherst, Massachusetts

INTRODUCTION

Western Reserve was the Connecticut of the West. Connecticut granted to her citizens, who had suffered by fire or otherwise at the hands of the British, one-half million acres of land at the far end of the Reserve known as "The Fire Lands" (1792).

A party of New England surveyors landed at the mouth of the Cuyahoga July 22, 1796 under the leadership of Moses Cleaveland (1754-1806). By 1800 there were 20 people in Cleveland. They had come to better their worldly status and had brought with them high ideals of family, school, church, and town meeting.

Twenty-nine pioneers left Goshen, Connecticut, in April 1800 and settled at Hudson, named after David Hudson, a descendant of Henrik Hudson. Doctor Moses Thompson being one of them walked back to Connecticut to get his wife and child. Until 1810 Moses Thompson, then 34 years old, was the nearest physician to Cleveland. Besides practicing medicine Dr. Thompson was interested in agriculture and stock raising. He was a liberal subscriber to the founding of Western Reserve College (1826).¹

The settlers were occupied in conquering the forces of nature. The path from Albany was nothing but a forest trail and it took three months to travel the route by ox team. The cabins were made without doors or windows and the rafters were hewed with an adze. The openings between the logs were chinked with clay. The bedsteads were made of poles and elm-bark cords. The wooden plates were called trenchers and corn bread was the staple diet. It took a complete day or more to get the grist at Newburgh. Flax and buckskin was the basis of clothes. Whatever the colonists had was obtained from Nature's storehouse.

Western Reserve University, the Yale of the West, was founded at Hudson (1826) to prepare pious young men for the ministry and to give western youth some of the advantages

¹ Waite, Frederick C. *Moses Thompson, Pioneer Physician*. Bulletin of the Cleveland Academy of Medicine.

that were had in the East. Elizur Wright was the first professor of Natural Philosophy at Western Reserve College (1829–1833), p. 22.² The museum occupied the third floor of the Athenaeum. Elias Loomis, the famous astronomer, held the chair (1836–1844) as well as Charles Augustus Young (1856–1866). William Edwards Morley (1838–1923), the distinguished chemist, was at Western Reserve College for a long time (1869–1906). Doctor Morley was famous for work on the atomic weight of oxygen and was associated with Albert A. Michelson, professor of Physics at the Case School of Applied Science (1883–1889).

The College moved from Hudson to Cleveland in 1881.

Gray, Agassiz, Allen, Barton, and Leidy received their impetus in Natural Science in medical schools. Dr. John Lang Cassels and Asa Gray studied botany under James Hadley (p. 23).² Dr. Cassels was born in 1808 near Glasgow, Scotland, and came to the United States in 1827. Dr. Cassels was at Reserve College from 1843 to 1873. Dr. Cassels occupied the chair of *Materia Medica* and Botany at the Medical School which existed in Cleveland (1843), while the liberal arts college was at Hudson. Professor Cassels in his introductory talk to a course of lectures on Botany so stimulated his class that they requested that it be printed.³ "I would not envy the possessor of the heart who can look upon Nature, when clothed in all her midsummer glory, with stoic indifference . . . no man, in his sober senses, can, for a moment, suppose that the laws and arrangements of Nature are unworthy his observation. . . . It is a melancholy fact, that our farmers, the noblemen of our country, are generally destitute of this, to them, indispensable information. . . . The study of botany may be advantageously employed as a means of mental improvement, an essential element in every accomplished physician's education."

The history of natural science at Western Reserve University also traces back to Harvard through another lineage. William Keith Brooks, a native of Cleveland, received his Ph.D. from Harvard (1875) and that summer conducted a laboratory and field course in biology at a downtown high school in Cleveland. Francis Hobart Herrick (b. 1858, Woodstock, Vermont) took his Ph.D. under Brooks (1888) and was appointed instructor in

² Waite, Frederick C. *Natural History and Biology in the Undergraduate Colleges of Western Reserve University*. *W. R. V. Bulletin*, Vol. XXXII, No. 13, July 1, 1929.

³ Prof. Cassels' Introductory Lecture delivered before the Medical Department of the Western Reserve College in Cleveland (1846).

Biology in Adelbert College. John Paul Visscher, the present head of the biology department, also came to Western Reserve University the same year that he received his Ph.D. from Johns Hopkins (1924). It is interesting to note that upon the dedication of the Biology Building (1899) that Dr. Brooks gave the address on "Scientific Laboratories."

Dr. Francis Hobart Herrick founded biology at Western Reserve University upon a broad basis. He had just completed two years of service when he proposed to start a Cleveland Museum upon liberal principles. John Hay was in the audience to which Dr. Herrick presented his plan. Dr. Herrick recommended "No attempt . . . to amass miscellaneous collections of nondescript character to bewilder the visitor, and to give him the impression that the animal kingdom is a mighty maze without a plan. The need is rather for a teaching collection . . . artistically and naturally mounted. The local fauna of the lake region . . . would be a permanent source of pleasure and instruction to old and young alike. . . . To have smaller and more compact collections . . . which an intelligent public wishes to know about without wading through a mass of technical detail."⁴ This led to the development of a museum on the top floor of the Biology Building which was a forerunner of the Cleveland Museum of Natural History. In recognition of Dr. Herrick's work the incorporators of the Cleveland Museum of Natural History asked Dr. Herrick to sign the articles on the first line and elected him vice-president.⁵

Dr. Herrick has omnivorous interests. He devoted considerable time to the lobster (2 vols., 1895). His *Home Life of Birds* (1901) was made possible by close-up photography and was a forerunner of the popular illustrated books on birds and mammals in their native habitats which soon followed. His *Life of Audubon the Naturalist* (1907) took him to remote corners of France and Mississippi. Following appointment as Professor Emeritus (1929) his portrait by Wm. J. Edmondson was unveiled in commemoration of the first teaching of laboratory biology in Western Reserve. It hangs in the lecture room of the Biology Building as a companion portrait of Dr. Jared P. Kirtland.

⁴ A Plan for a Museum of Natural History in Cleveland. A paper delivered Nov. 1, 1890 before the Senate of Western Reserve University by Francis Hobart Herrick. One of few copies of the original paper is possessed by the Cleveland Museum of Natural History.

⁵ An Appreciation of Dr. Francis Hobart Herrick. Published by the Cleveland Museum of Natural History. December 1, 1928.

As Professor Emeritus Dr. Herrick has led a rich life. His study of the American Eagle at Vermilion, Ohio, extended over a number of years (1922-1934). When his wooden tower in a tree fell he had an 80 foot steel tower erected (1926). This was a unique experiment. Motion pictures were taken at the Eyrie at close range to show the life history of the eagle. This led to the first book about our national bird, *The American Eagle* (1934). The book is both scientific and popular, with excellent pictures. Dr. Herrick's interests are not confined to natural history. At his home he has a fine amateur collection of old china.

THE ARK AND ARKITES

The Ark was a club room or a "headquarters for loafers" on the site of the old Federal Building, Public Square. It was called the Ark as it resembled Noah's Ark with "two of every kind." The members were known as Arkites. Like the Yosian Club of New York City, there were no by-laws and no systematic records. It was probably Dr. Kirtland who first started the young men toward nature interests. Cards, chess, athletic feats, and conundrums gave way to nature collections which soon crowded the workshop. "Captain Ben" Stannard explored the lake in the interest of the American Fur Company and incidentally for his own interest in nature. William Case (brother of Leonard Case who founded Case School of Applied Science) had uncertain health and adopted outdoor life. At first a hunter he soon became an enthusiastic naturalist and finally was an assistant to Audubon. When visiting the Franklin Institute in Philadelphia (1844) he said, "Cleveland must have something like this" (p. 27),⁶ and in 1859 began to erect a building for the Young Men's Library Association and the Kirtland Society. The Ark collection became a nucleus of the Kirtland Society collection. Later the birds went to Western Reserve University and the mammals to the Case School of Applied Science. Dr. Elisha Sterling (1824-1890), an eminent surgeon and Arkite, was a naturalist of the 1855 government expedition to the Pacific Coast and became an expert on fish culture. Oliver Hazard Perry was one of the "habitués" of the Ark. Many of the members became founders of the Cleveland Academy of Natural Science.

⁶ Case, Eckstein. *Notes on the Origin and History of the "Arks."* 130 copies printed for the Rowfant Club. 1902.

THE CLEVELAND ACADEMY OF NATURAL SCIENCE

In 1843 a branch of Western Reserve College located at Cleveland under the name of the Cleveland Medical College. Two years later the Cleveland Academy of Natural Science was formed (1845) with Dr. Jared P. Kirtland as president. He started a museum on the second floor of the Medical College. The members gave sundry lectures on scientific subjects. A brief résumé of some of the members and their contributions will show the calibre of the membership and their wide range of interests.⁷

Colonel Charles Whittlesey (1808–1886) was born in Connecticut. His family moved to Talmadge, Summit County, in 1813. He worked on farms during vacations until 1827. In 1837 he was appointed to the Geological Survey of Ohio and from 1847 to 1851 he made a mineral survey around Lake Superior for the U. S. Government. His Geological Survey of Wisconsin was done from 1858 to 1860. He was therefore well qualified to speak before the Academy about the "Alleghany Coal Field" (1854) and the "Chronology of Trees" (1858). For 15 seasons Whittlesey lived among the Indians and Voyageurs. He took time out for the Civil War. To his energies is mainly due the organization of the Western Reserve Historical Society.

John Strong Newberry (1822–1892) came of old Puritan stock from Windsor, Connecticut. His father moved to Ohio in 1824 and founded the town of Cuyahoga Falls. J. S. Newberry graduated from Western Reserve College at Hudson (1846) and Cleveland Medical College (1848). He gave up practice to go as geologist on the government exploring expedition in Northern California and Oregon (1855). In 1857–1858 he explored for 500 miles up the Colorado. He was professor of Geology at Columbia College, New York City (1866), and State Geologist for Ohio (1869–1875). In 1853 Dr. Newberry lectured before the Academy on "Fossil Plants." His work was of a most important character and his writings won him a wide reputation. He was rewarded by being elected president of the American Association for the Advancement of Science.

Theodatus Garlick (b. 1805) was the son of a Vermont farmer. In 1816 he started on foot for the Western country. He became a Cleveland surgeon and later was elected vice-president of the Academy of Natural Science. Dr. Garlick was the first in this

⁷ *Proceedings of the Cleveland Academy of Natural Science, 1845–1859.* Published by a Gentleman of Cleveland, 1874.

country to demonstrate the practicability of breeding fish by artificial means (1853-1854). He used the spawn of speckled trout.⁸ Dr. Garlick gave a paper before the Society (1854) on the "Artificial Reproduction of Fishes." Dr. Garlick also had talent as a sculptor and his masterpiece was probably of Dr. Jared P. Kirtland—a work of love. He made the first daguerreotype picture (landscape) taken in the United States (1839) having made his own instrument.

Dr. John Lang Cassels lectured to the Academy in 1853 on the "Mosses Found in the Vicinity of Cleveland."

Dr. Jared Potter Kirtland talked on the "Diurnal Lepidoptera of Northern Ohio" (1854).

Jehu Brainerd lectured on the "Influence of the Study of the Natural Sciences on the Young" in the lecture room of the Medical College (p. 114).⁷ This was on February 13, 1855. It is of special interest that such a talk was given at so early a date and it is to be regretted that no further record appears in the proceedings.

John Kirkpatrick (1819-1869), like Dr. Cassels, was born in Scotland and came to Cleveland (1843). He was secretary of the Academy. He spent his leisure time reading natural history books and studied the entomology of the region. His collection was donated to the Kirtland Society. Kirkpatrick left the machine shop to edit the *Ohio Farmer* (1856-1859) (pages 174-178).⁷

THE KIRTLAND SOCIETY OF NATURAL SCIENCES

The first and only president of the Cleveland Academy of Natural Science was Dr. Jared Potter Kirtland (1845-1865). In his honor the Academy was changed to the Kirtland Society of Natural Sciences (1869). For that reason the sketch of Dr. Kirtland's life has been reserved until this part of the story.

Jared Potter Kirtland (1793-1877) was the grandson of Dr. Jared Potter (1742-1810) of Wallingford, Connecticut, by whom he was adopted. His grandfather had extensive orchards and gardens. "While yet a boy he was a diligent student of nature—a veritable human worm, boring his way to knowledge by a precocious system of analysis and investigation applied to everything he touched and saw. At the age of twelve years he was an expert at budding and grafting . . . and he began the

⁸ From a newspaper clipping pasted on the back cover of the *Proceedings of the Cleveland Academy of Natural Sciences*. A letter from Judge E. D. Potter to Dr. Garlick, Supt. Toledo Fish Hatchery, May 8, 1876.

study of the Linnaean system of botany and the system of producing new varieties of fruit by crossing."⁹ He also helped manage a plantation of white mulberry for rearing silk worms. It was at this time that he discovered that the female could lay fertile eggs without the aid of the male (parthenogenesis).¹⁰

In 1810 young Kirtland came to Ohio on horseback. He taught school for a year at Poland, Ohio. At Buffalo, on this first trek west, the fishermen laughed at the Yankee who had never seen a whitefish, but they soon discovered that even the "greenhorn" could teach them something. He taught the farmers near Poland the art of fruit propagation. He also became interested in his father's apiary.

At the University of Pennsylvania (1813-1814) he became acquainted with Barton. While attending the Yale Medical School (M.D. 1815) he studied geology under Silliman. During his spare time he was engrossed in the study of herbs, trees, birds, minerals, fishes, insects, and shells.

Kirtland came to Ohio to live in 1823. For some time he was a professor at the Ohio Medical College at Cincinnati (1837-1842). In 1837 he was assistant on the Geological Survey of Ohio under Professor William Williams Mather (1804-1859). In this connection he prepared a basic study on the Zoology of Ohio which was published in the second annual report of the survey. Like Agassiz, he had a special interest in fishes. His descriptions and drawings of fishes were published in the *Journal of the Boston Society of Natural History* (1839-1846).

In 1843 Kirtland was one of the founders of the Cleveland Medical College (1843-1864). In every medical class some of his pupils became specially interested in Natural Science. His enthusiasm for natural science was contagious and his personal magnetism was effective. As Newberry aptly says, "Few men came within the sphere of his enthusiasm . . . who saw . . . the flowers blooming for him as for no other, the fruits blending for him their fairest forms and richest flavors, the very weeds and stones becoming eloquent and poetical at his beck—could ever go away and look at life and nature with the same eye as before" (page 133).¹⁰

Kirtland was a contemporary and correspondent of Agassiz. In 1851 Agassiz ended a letter to Kirtland by saying, "I am

⁹ From *Cleveland Herald*, December 10, 1877.

¹⁰ Newberry, J. S. "Jared Potter Kirtland." A paper read before the National Academy, April 18, 1879.

sorry to be tied for the whole summer in Cambridge—must now make up for the time spent in the field by work in the closet. Unfortunately, I have reversed the seasons. With high regard, sincerely yours, L. Agassiz.”

Kirtland discovered that *Unios* have separate sexes, helped plan the first water system of Cleveland, and developed over 40 new varieties of cherries which won him the title of “Cherry King.” In 1851 he was convinced that typhoid fever comes from drinking water—thirty years before bacteria were known (page 162).¹¹

“Great as was his influence upon professional men and those engaged in scientific pursuits, yet perhaps greater was his influence along scientific lines upon the laity” (p. 163).¹¹ “His name was known at nearly every farmer’s fireside in northern Ohio” (p. 164).¹¹ “He taught over 3000 medical students” (p. 165).¹¹ Perhaps no better summary can be presented than the quotations just given from Dr. Waite who, although Professor of Histology and Embryology at the Medical School of Western Reserve University, has done more than anyone else to preserve the history of Natural Science in the Western Reserve. It was to such a man as Kirtland that the Cleveland Academy of Natural Science did honor by adopting the name of the Kirtland Society of Natural Sciences.

The following interesting notes are taken from the proceedings of the Society.¹² Wherever the initials E. S. appear they refer to Dr. Elisha Sterling who evidently kept a journal of important happenings in Natural History and often added interesting data and comments. His style and humor are Thoreau-like.

February 27, 1869. Group met to organize a Natural History Society.

March 24, 1869. Election of officers. Professor J. P. Kirtland, Pres. At each meeting resident and corresponding members were elected. Such names as E. D. Cope of Philadelphia and Alexander Winchell, State Geologist at Ann Arbor, Michigan, appear in the records.

April 13, 1869. It was customary to paste clippings in the book. Under this date appears the following: “Cornell Uni-

¹¹ Waite, Frederick C. “J. P. Kirtland, Physician, Teacher, Horticulturist, and Eminent Naturalist.” Presidential address before the Ohio Academy of Science, April 18, 1930. *Ohio Journal of Science*. Vol. XXX, No. 3, May 1930.

¹² From *Proceedings* of the Kirtland Society of Natural Sciences. Original manuscript in Western Reserve Historical Society. Photostat copy at the Cleveland Museum of Natural History.

versity has a collection of shells numbering 5,000,000." A notation was added: "What a chance for a clam bake for the Cornell girls. Better put it 5,000."

On the same date a newspaper clipping regarding the Cleveland market gave the following: "Pigeons \$3.00 per dozen, snipe \$3.00 per dozen, meadow larks \$1.75 per dozen." With this was a note added by pen: "I must confess when I saw, this morning, some two dozen male meadow larks strung by the neck in the door of a huckster's shop, that the extermination has really commenced against the feathered race. Where are our laws for the protection of game and useful birds?" E. S.

January 5, 1875. The records contain a great deal about birds and the weather. This date was "Spring like weather. Saw a pair of bluebirds on the Public Square. The European Sparrow soon drove them away." E. S.

From December 26 to January 1, 1876. Maple sugar was made at many of the camps on the upper Cuyahoga and Loraine County.

June 30, 1877. A clipping: "The potato field at Mulheim on which the Colorado beetle made its appearance has been covered with petroleum and tan bark and set on fire, the government indemnifying the proprietor." E. S. makes a comment. "That's the way to do it. Well! Some of those people gave us in 1776 the Hessian soldier and the Hessian fly. It is now no more than fair that we should return to them after a hundred years some slight token of remembrance."

Henry Wood Elliott, the last surviving member of the Kirtland Society, waged a forty year fight (begun in 1872) to save the fur seals of Alaska. The John Hay-Henry W. Elliott Fur Seal Treaty, signed August 24, 1912, is an important date in biological accomplishment.

THE PUBLIC SCHOOLS AND NATURE EDUCATION

The first school in Cleveland (about 1817) did not antedate Western Reserve College by ten years. It was built when Euclid Avenue was known as the Buffalo Road and Fairmount Boulevard was the road to the grist mill at Newburgh. It was really a district school with the windows high enough so the children could not look out and be disturbed—not a promising outlook for nature study. Only those children attended who could pay the tuition.

Until the school year 1871-1872 the children of Cleveland had

to get their nature study in spite of the schools. As in other localities, the children had to wait for the right personality to come along as a nature leader. This was in the person of Harriet L. Keeler (1846-1921) whose father was a farmer. Being active and of keen intellect she taught a district school in Cherry Valley at fourteen years of age. Graduating from Oberlin (1870) she soon became Superintendent of Primary Instruction in the Cleveland Public Schools (1871-1879), a teacher at Central High (1879-1909) and by 1912 was Acting Superintendent of Schools. The movement was also fostered by Andrew J. Rickoff, Superintendent of Schools.

It is necessary to search the Annual Reports of the Board of Education to get a notion of the advent of nature study in the Cleveland Schools. In Superintendent Rickoff's report for 1871-1872¹³ he says that "Esteeming object lessons, as we do, to be among the best of educational means, it is to be regretted that we cannot report better results in the attempt to introduce them in our schools" (p. 100).¹³ He goes on to say that the "Board of Education at the beginning of the current year introduced the study of the first principles of Natural Philosophy into the C and B Grammar Grades, and by the adoption of Mr. Hotze's excellent book, *First Lessons in Physics*, gave the subject its proper position in the curriculum of the schools" (p. 102).¹³ It is interesting to note the books listed as textbooks: besides Hotze's there are McGuffey's *Readers*, Guyot's *Elementary Geography*, and Miss Youman's *Botany*.

Monday Morning was the title of a series of papers prepared and printed under the direction of Miss Keeler. They were circulated among the schools every Monday morning as reading material for the C Primary Class. The four stories for the issue of April 29, 1872 carried the following titles: "The Story of the Leaf," "The Hen and Her Ducks," "Charlie and the Mouse," and "Letters from the Country."¹⁴

Miss Keeler's efforts evidently bore fruit early for Dr. S. G. Williams, Principal of Central High School, in his report for 1873-1874 emphasized that it is "A source of great satisfaction to those engaged in our high school work, that the elements both of Physics and of Botanical observation are now being taught in the lower grades of the schools of the city" (p. 73).¹⁵

¹³ Cleveland School Board. 36th Annual Report. Superintendent's Report for School Year 1871-1872

¹⁴ *Monday Morning*. Vol. I, No. 3. Monday, April 29, 1872.

¹⁵ Cleveland School Board. 37th Annual Report, Board of Education. 1873-1874.

By 1875 Harriet L. Keeler's *Report on Object Lessons* appeared.¹⁶ "The preparation of lessons upon common animals as cat and cow . . . will tax one's efforts almost beyond belief. . . . By meeting the teachers at the Institute and at the monthly meetings throughout the year she (Mrs. Rickoff)¹⁷ made it possible for all to give Object Lessons intelligently. . . . With each returning year our teachers are becoming better able to face this 'bete noir' of modern teaching." Evidently textbooks were scarce and the teachers were ill prepared—a condition that was to be all too prevalent for the next fifty years.

Harriet L. Keeler served the Cleveland Public School system for about 38 years (1870–1908) which accorded her high recognition when she was asked to occupy the position of Superintendent of Schools, January–September, 1912. She was the first and only woman to hold that position.

Harriet L. Keeler is best known to nature people as the author of *Wild Flowers of Early Spring*, *Our Northern Shrubs* and *Our Garden Flowers*. In the preface of her best known book, *Our Native Trees*, she writes: "To such of the general public as habitually live near fields and woods; or whose love of rural life has led them to summer homes in hill and country or along seashore; or whose daily walks lead them through our city parks and open commons."

In the 1700 acre Brecksville Reservation of the Cleveland Metropolitan Park System 300 acres that possess a diversity of native trees have been set aside as the Harriet L. Keeler Memorial Woods. Through these woods winds a nature trail a mile and a half long. At the entrance there is a granite boulder which was dedicated October, 1936. The inscription on the plaque says: "Harriet L. Keeler 1846–1921. Teacher—Author—Citizen. She continueth as do the Generations of the Woods she loved."

The *School Garden* movement in Cleveland was inaugurated in 1904 by Louise Klein Miller. It was conducted jointly by the Home Garden Association and the Board of Education. In 1905 the latter assumed control of the work.¹⁸ Miss Miller was called the "Curator of School Gardens." The activity was put in the Department of School Hygiene because it was regarded as a health measure.

¹⁶ Cleveland Board of Education. 39th Annual Report for year ending 1875.

¹⁷ Mrs. Rebecca D. Rickoff, wife of Superintendent of Instruction, Andrew J. Rickoff.

¹⁸ *Bulletin* 252. U. S. Dept. of Agriculture.

Louise Klein Miller was born on a farm near Dayton. She was lucky enough to go to school before the days of probation officers or she would have been summoned to the juvenile court. She couldn't see any sense in partial payments and ran away from school. She studied under Parker and Jackman at the Cook County Normal and later at Cornell. She taught at the Lowthorpe School of Horticulture at Groton in its first two years. She was also supervisor of Nature Study at Saginaw, Michigan, and at Detroit before coming to Cleveland.

Superintendent William H. Elson in 1909 "recommended the introduction of gardening into the curriculum of the grammar schools, attached to the work of the sixth grade; second, the establishment of a high school course in Agriculture" (p. 33).¹⁹ At that time school gardens existed in 12 school yards and in 4 vacant lots. There were 6 gardens for normal children, 9 for defectives, and 1 for delinquents. The Boys' Detention Home School started gardening in 1908. The Oakland Manual Training School had a kitchen garden which included such things as rhubarb, strawberries, raspberries, blackberries, flax, hemp, 9 varieties of tomatoes, and a tree nursery. The Willard Farm School, started at West 89th and Willard Avenue (May, 1911), used science and the art of agriculture as an aid to education. It was regarded as a testing of the theory that people learn readily the things they want to know, such as the growing of plants (p. 51).²⁰ The Memorial Garden at East 152nd Street was planted in 1911 in memory of the 165 children and one teacher who were blotted out by the Collinwood Fire (1908) (page 50).¹⁹ The Doan School Garden was abandoned in 1911 when the lot was sold. The Rosedale School Botanic Garden was abandoned in 1911 for a vegetable garden.

Louise Klein Miller made the following terse statement in her report for the school year 1912: "A new garden was started at Longwood School. Many of the plants were stolen. That was encouraging. If people love flowers well enough to steal them they should have flowers of their own. The school garden activities must be extended into the home. Most of the children did not know one plant from another" (page 31).²¹ Today Miss Miller is Landscape Architect for the Cleveland School Board. Her special interest is the Memorial Garden at Collingwood.

¹⁹ Cleveland Public Schools. 73d Annual Report of the Board of Education for the School year ending August 31, 1909.

²⁰ 75th Annual Report of the Board of Education, 1911.

²¹ 76th Annual Report of the Board of Education for year 1912.

Superintendent J. M. H. Frederick in his report for the 77th School Year ending in 1913 tells about the introduction of Scientific Agriculture at the West Technical High School (p. 81).²² They had a greenhouse, a truck garden, and sprayed the orchard of a nearby farm.

In 1926 Paul R. Young was made Director of School Gardens. A farmer boy from Ithaca, he graduated from Cornell in 1916. In 1935 he supervised the Cuyahoga County Relief Administration gardens which meant 9000 people. His School Garden registration meant 11,000 more and instruction in gardening in the schools reached 45,000.²³ This represents "big business" and no one who knows Cleveland can doubt that it is garden conscious. This is due to many factors besides the efficient work of the schools.

One of these which should receive mention at this time is the *Children's Flower Mission*. In 1906 at the frequent suggestions of Fred Barton, who published the *Expositor* and was one of the founders of the West Side Y.M.C.A., and Mr. Pelton, who managed the Benjamin Rose Estate, Mr. R. L. Templin decided to offer a list of flower seeds to Sunday School teachers and superintendents for the purpose of distribution to the children at Easter time. The children were to plant the seed and in the fall they were to bring the flowers they had raised to Sunday School. After Sunday School the flowers were taken to hospitals and to homes where illness existed. Mr. Barton's publication was issued monthly to ministers who introduced the idea to their teachers. This continued until 1912, but at a financial loss.

In the meantime many public school teachers had asked to try the plan with their pupils. Mr. Templin conceived the idea of the penny-pocket flower and vegetable seeds for children connected with schools, whether they wished to have a garden project either at school or at home. Instead of seeds having to be cheap to make the price, the necessity existed right from the beginning to get only the best quality of seed so that inexperienced children could succeed. At that time Mr. Templin was one of the best posted seedsmen and nurserymen in America. It is interesting to note that an ideal plus ability made the venture self-sustaining. Today not only the school system of Cleveland but of such large cities as Detroit, Pittsburgh, and New York use the seeds continuously.

²² 77th Annual Report of the Board of Education for year 1913.

²³ *Cleveland News*, April 1, 1935.

The Children's Flower Mission is the School Garden Department of the Templin-Bradley Company. Floyd Bradley, the president, is carrying on the traditions established by Mr. Templin. Paul Young has written a *Teacher's Handbook* and that with an individual order blank for each pupil makes an ideal set-up for arithmetic. An interesting example of second-grade number work centering about the making of a garden was written by Alma Caldwell, General Supervisor (p. 18).²⁴

Cleveland has nine curricula centers. The Doan School, East 105th Street, was chosen as the curriculum center for elementary science as it represented the typically congested school district without any particular natural advantages. The children at once attained wide reading interests. Tests showed that they were two grades ahead in reading ability but that arithmetic was lagging. This was easily corrected. The school has become an apprentice shop where skilled teachers in elementary science graduate into the system. Miss Mary E. Melrose, Supervisor of Elementary Science, was one of the few supervisors to weather the depression. Elementary science is probably established on as high a grade in Cleveland as in any city in the country.

Henry Turner Bailey (1865-1931), Director of the Cleveland School of Art, was a member of the Burroughs Club, the Wild Flower Club, and the Cleveland Bird Club. His recreation was nature study. He was ahead of established fact when he said: "When we are wiser, we will not run the buses of the Board of Education to bring rural children into city schools, but to take city children into the country, that they may learn to know and love God's first revelation to man, and feel at home in the natural world because they are well acquainted with it."²⁵ Those who were fortunate enough to be in the field with Dr. Bailey realize his keen ability in identifying birds or in sketching veteran trees such as the old white pine in the Chagrin Valley which he called "Demosthenes" and his chalk talks on nature remain in memory as a beautiful sunset. The "Dean Bailey Hikers" (1929) is a club of old friends who meet yearly in the open which was Henry Turner Bailey's shrine. No greater tribute could be paid to one's nature interest unless it be to make it possible for city children to "learn to know and love God's first revelation to man."

²⁴ Caldwell, Alma. "Arithmetic Steps Outdoors." *American Childhood*, May 1932. (Miss Caldwell is sister of Dr. Otis W. Caldwell, well known to all naturalists.)

²⁵ National Education Association Addresses and Proceedings. 1932. Vol. 70. p. 477.

THE CLEVELAND SCHOOL OF EDUCATION

The Normal School was supported by the city for 62 years (1874-1936). The school was legalized in 1908 and went into the new building in 1910 (p. 27).²⁶

Dr. Jean Dawson (Ph.D., Michigan) was listed in the catalog of the Cleveland Normal Training School (1910-1915) as teacher of Biology and Physiology. Her anti-fly campaign (1911) was run in cooperation with the Chamber of Commerce. She was co-author with Clifton Hodges of Clark University of *Civic Biology*, an epoch-making volume in presenting biology on a practical basis. Dr. Dawson later married Dr. Hodges.

Ellis C. Persing, Assistant Professor of Elementary Science, is best known for his *Science Readers* published by D. Appleton and Company. He is the instigator of the Cleveland Natural Science Club, the membership of which is mostly teachers in the elementary schools. Through the help of federal funds, the Club has recently constructed a "Science Lodge" in the South Chagrin Reservation.

The "Educational Museum" was fathered by William M. Gregory. Its purpose is to furnish visual materials for the Cleveland Schools. Lantern slides, pictures, stereopticons, moving picture projectors and the like are delivered by truck once a week. Over 5000 lantern slides are handled daily. The idea of visual education has grown so rapidly that the Museum has occupied three different buildings during the past eight years. It originated at the School of Education building when Mr. Gregory was Professor of Geography.

The Nature Guide School was opened in June, 1928, at Western Reserve Academy, the original home of the University. A 500 acre farm and forest made an ideal outdoor school room. Sixty-five teachers and thirty-two children attended each summer for a period of four summers when it was closed by the "Depression." In 1931 there were seven graduates—who came from Ohio, Illinois, Minnesota, Pennsylvania and Oregon. Credit for the outdoor courses was allowed by several Universities. Although of short duration the school had the effect of making the teachers of Cleveland outdoor-minded.

The first extension courses were offered in 1915-1916. Teachers were allowed to have majors and minors. By 1936, when the Cleveland School of Education was closed because of with-

²⁶ 81st Annual Report of the Board of Education.

drawal of support by the School Board, there were nearly a hundred and fifty elementary school teachers who were majoring in Nature Education. This was a basic factor in the equipping of the public school teachers to carry on the present high grade work in elementary science.

THE CLEVELAND MUSEUM OF NATURAL HISTORY

As already stated, Dr. Francis H. Herrick was father of the idea of a Cleveland Museum of Natural History. The idea remained fallow until Harold T. Clark, during the World War, was impressed by the museums of Europe. He felt that a city of a million ought to have a natural history museum. Being an enterprising member of the Chamber of Commerce he marshalled forces. Mr. Clark with Lewis B. Williams and Alwin C. Ernst got fifteen public-spirited men who agreed to give \$1000 apiece for three years. As a result the Museum was incorporated December 13, 1920.

By 1922 the Museum began cooperation with the Cleveland Public Schools. At one time there were four museum teachers of nature study—two who met classes of children at the Museum and two itinerant teachers who visited the schools. Lakewood and Shaker Heights schools were included in the educational program (1928–1932) until the depression necessitated curtailment of expenses.

Pocket Natural History is the title of a series of publications begun in 1922. *Ohio Trees*, *The Mound Builders*, and *Ohio Fishes* are the titles of some of these useful handbooks which are abundantly illustrated (15 cents each).²⁷

The Cleveland Museum sponsored the first trailside museum in Ohio, opening it in North Chagrin Metropolitan Park Reservation July 4, 1931. Graham T. Webster (Harvard, 1931) was in charge. Arthur B. Williams was appointed Museum Naturalist (1930) with the specific duty of developing the educational resources of the Metropolitan Parks. His studies of the beech-maple forest area as a thesis for his Ph.D. at Western Reserve University is an outstanding example of the ecological study of a given area.²⁸

Since 1870 a small group of Cleveland naturalists have been interested in fossil fishes. Dr. John Strong Newberry described

²⁷ Notable Collections, Exhibits, and Achievements of the Cleveland Museum of Natural History. 1937.

²⁸ Williams, Arthur B. The Composition and Dynamics of a Beech-Maple Climax Community. *Ecological Monographs*. 6: 317–408. July 1936.

many and A. A. Wright, Professor of Geology and Natural History in Oberlin College, published results of his investigations. The fossils are usually enclosed in concretions and represent the largest Devonian fishes found. Entire sharks up to five feet long have been discovered and the jaws of some that must have been twenty feet.²⁹ After fourteen years 1707 specimens of Cleveland shale fishes were numbered in the Museum collection. Most of this work is due to the efforts of Professor Jesse E. Hyde.

One hundred acres near Kirtland, twenty-five miles east of Cleveland, for the Holden Arboretum was presented to the Museum by Mr. and Mrs. Benjamin Patterson Bole, and B. P. Bole, Jr. (1930). A trust fund had been established in 1913 by Albert Fairchild Holden. Ernest H. Wilson of the Arnold Arboretum, after two visits, said: "If all your plans transpire, you will have the greatest arboretum in the world."³⁰ The Arboretum is fortunately located near Little Mountain—a northwestern foothill of the Alleghenies. It partakes of the flora of the Mountains and of the Great Plains and hence is a strategic locality for an outdoor tree laboratory and near enough to a great metropolis to serve the public.

The first Cleveland Nature Trail was made in 1928 and the following year there were four nature trails in the Metropolitan Parks. Cleveland has nine metropolitan park areas and the nature trails as well as the trailside museums represent cooperative projects of the Museum and Park Boards. The man most responsible for the trails is Edmund Cooke who came from the Field Museum of Chicago to take charge of the Department of Education at the Museum. Mr. Cooke is noted for his originality of purpose and expression. He writes that the educational aim of nature trails is to provide "experience in interpreting the spirit of a particular woodland" (page 6).³¹ He goes on to say that "Taxonomic punctiliousness is pointless" (page 18) and that "The nature trailer . . . is working for John Doe to whom a Latin name is so much mumbo-jumbo" (page 18).

The Hanna Star Dome (1936) was a gift of Mrs. Paul Moore in memory of her father, Mr. Leonard C. Hanna. "It is for the use of the people of Cleveland and especially for the children

²⁹ Hyde, Jesse E. *Fossil Fishing in Cleveland Shale*. Vol. I, No. 1. First of Popular Publications of Cleveland Museum of Natural History. Nov. 1928.

³⁰ Halliday, Dean. Significance of the Holden Arboretum. *Garden and Home*. Vol. IV. No. 9. January 1931.

³¹ Cooke, Edmund. *Nature Trails in Cleveland*. American Association of Museums. New Series. Number 10. Washington, D. C. 1930.

and is dedicated to wise living through knowledge and appreciation of the orderliness and beauty of our changing universe." The dome is 16 feet in diameter and is equipped to present the stars as seen any night in the year. It is not an over-pretentious undertaking as has recently appeared in larger cities and in the long run will undoubtedly do as much service.

The director of the Cleveland Museum of Natural History (since 1931) is Harold Madison who came from the Roger Williams Park Museum of Providence to head the department of education. Mr. Madison has always been interested in the museum as the people's university. Perhaps to him more than anyone else is due the broad public relations of the museum. Besides projects already noted, the Natural History Museum has for a long time cooperated with the School of Art, the School of Education, the Crile Clinic, the Cleveland Clinic Research Foundation, the various newspapers, the social service organizations, and the Cleveland Summer Camps. It is truly a service institution.

SOME OTHER CLEVELAND ADVENTURES IN NATURAL SCIENCE

1. *The Cleveland Press* has had the daily science column of David Henry Dietz since 1921. As a matter of fact he became a member of the editorial staff while a freshman (1916) at Western Reserve University. His *Story of Science* (1931) is written in his own popular style. He taught astronomy at Nature Guide School and has received honors for his science editorials for the Scripps-Howard Syndicate.

The Public Service Bureau of the *Cleveland Press* has sponsored notable lectures for the Natural History Museum by such men as August Piccard, Mr. and Mrs. Martin Johnson, and Nansen. In 1937 they published *Cleveland's Nature Trails*, by Dr. Arthur B. Williams of the Museum staff. The booklet is dedicated "to the nature lovers of Greater Cleveland" and contains a wild flower time table. The Cleveland Board of Park Commissioners was formed in 1871 and the park plan originated in 1893. The *Press* estimates that five million visit the Cleveland Metropolitan Park System annually which is greater than the number of annual visitors to all the national parks combined.

The *Press* also issued a Nature Comic Strip entitled "Dot and Dick in Nature Land." It aimed to tell the truth through "funny pictures" which were issued on a high plane. It is unfortunate that they had to be discontinued.

2. *The Cleveland Plain Dealer* has a daily nature script by Carl T. Robinson which is usually in the form of a nature calendar and is a valuable record of nature events over a long period of years.

3. *The Cleveland News* often has a nature column by Edna K. Wooley.

4. *The Cleveland Garden Center* was established by the Garden Clubs of Cleveland in an old boat house in Wade Park. It is an educational center for all things that pertain to the garden. It sponsors a lecture course, demonstrations, exhibits, a garden library and clinic. Pittsburgh and other cities have copied Cleveland's unique idea.

5. *Cultural Gardens*. Since the formation of the Shakespeare Garden several racial groups of Cleveland have sponsored gardens in Rockefeller Park. Some of these are the Germanic, Hebrew and Italian gardens. On Coventry Road, Shaker Heights, the Garden Club of Cleveland is perpetuating "the ferns and flowers grown by the Shakers" (1823-1889).

6. *The Andrew Squire Valleevue Farm* was presented to Western Reserve University by Andrew Squire, the "Dean of Cleveland Lawyers." It is under the supervision of Dr. Franklin James Bacon who has been at Reserve since 1927 as Professor of Pharmacognosy and Botany. His "drug garden" contains most of the well known medicinal herbs. The farm has an outstanding arboretum and a Council Ring was dedicated in the course in "Outdoor Leadership" in the summer session of 1935. The students from the physical education department of Mather College have converted one of the buildings into a headquarters for the Outing Club (1937).

7. *The Baldwin Bird Research Laboratories* are located at Gates Mills. Dr. S. Prentiss Baldwin began bird banding in the Spring of 1914. During the first four years he banded nearly 1600 birds. He carries on bird banding by systematic trapping. His principal work has been on the marriage relations of the house wren. He has started many students on an ornithological career and is an outstanding example of a business man who has returned to his first love—science. Although starting his investigations late in life he has made signal success.

8. *Nela Park* is the home of the experimental work of the General Electric. It is the "University of lighting" and offers unparalleled opportunity for classes to see demonstrations of electric lighting. School children meet in the auditorium by

appointment. By pressing buttons the stage portrays stages of street lighting down through the years. Competent lecturers tell about modern kitchens, gardening by artificial light and other wonders of the age of electricity.

SOME OTHER GREAT SONS AND DAUGHTERS IN THE WORLD OF SCIENCE

In a brief résumé of this kind it is impossible to do complete justice. Only a few representative naturalists can be added.

The Warner and Swasey telescopes have brought fame and fortune. Charles F. Brush was the father and perfecter of the electric arc and lighting system. These great sons have demonstrated the practical value of applied science.

Edmund Vance Cooke (Father of "Nature Trail" Cooke) has been selected to represent the nature poets. His *Moo Cow Moo* may be best known, but *How Did You Die* and *Patch of Pansies* testify to his ability as a thinker and reformer.

Mrs. E. C. T. Miller published the nature magazine called *Bluebird* for a number of years.

CONCLUSION

There is a legend that the usual morning greeting in Cleveland is "Have you cooperated today?" This might well be a fact in natural science for the scientists of the University and Museum serve on the boards of trustees of the Parks, Settlement Houses, Y.M.C.A., Scouting organizations, and Garden Clubs. Growing youth in Cleveland are given the best of nature opportunities and have a wide range of nature offerings from which to select. There is no more fertile field of nature education. The children are being taught to guard natural beauty, to conserve natural wealth and to enjoy the outdoors. The sources of such ideals are deeply rooted in their New England ancestry and a beautiful environment.

FOSSIL BLOOD CORPUSCLES

Fossil blood corpuscles of a lizard, which still show their structure under the microscope, have been found by scientists at Halle University, working on masses of animal remains excavated from the great lignite pits in the nearby Geisel valley. The geologic age is middle eocene, approximately 50,000,000 years ago.

SHALL WE HAVE A NEW CALENDAR?

BY EUCEBIA SHULER

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It may be surprising to many that for nearly one hundred years there have been considerations and proposals for a change in the calendar which is now in use by practically the entire world. Having become accustomed to the present scheme, many wonder why the plan is not entirely satisfactory. The basis for argument in favor of another calendar revision is the same as that offered for all previous calendar changes—the removing of defects that have never been adjusted completely and that have seriously handicapped the progress of social, economic, scientific, commercial, and religious development.

The main points of dissatisfaction are: the shifting dates for holidays and religious celebrations, particularly Easter; the shifting week which has its beginning on different days of the week and month; the unequal length of the months; the unequal division of the month into weeks; and the variations of the calendar from year to year. All these are serious defects for industry, finance, commerce, courts, and education programs.

As early as 1849 Comte, a Frenchman, attempted to remedy these difficulties by proposing a thirteen-month year. This plan, called the Positivist Calendar, was an elaborate arrangement giving to the months and weeks names of world famous characters.¹ For the last twenty-five years various organizations such as Chambers of Commerce, The World Calendar Association, The League of Nations, labor organizations, scientific organizations, and women's clubs have been giving attention to calendar reform. Legislative representatives of the United States and the British Government have introduced bills providing for calendar changes. Many business concerns have adopted a thirteen month calendar having four weeks to the month to facilitate the study and control of costs, statistical computations, reports and pay rolls. It is estimated that about 500 business organizations now use this scheme. It is significant that most of this number have adopted the new plan since the depression, that about three-fourths of them initiated the plan within the last few years, and that the number is increasing.

¹ For partial description of this calendar see P. W. Wilson, *The Romance of the Calendar*. New York, W. W. Norton and Co., Inc., 1937, pp. 258 ff.

In the light of the defects previously mentioned the following results are sought in a new revision of the calendar: (1) the stabilizing of holidays, (2) equalizing all periods to make them comparable, (3) having weeks begin and end on constant days of the week, (4) eliminating parts of weeks and thereby banishing pay-roll difficulties, and (5) saving in cost of printing and distributing new calendars each year. On the other hand there are obstacles and objections to calendar reform. One difficulty is the extra day over the fifty-two weeks in each year and the extra day in the leap years. These problems, however, can be handled as will be pointed out subsequently.

There are two main proposals for calendar change; one is the thirteen month calendar, each month containing four weeks; and the other is the calendar of twelve months. One quarter of each calendar follows and the chief advantages and disadvantages of both are pointed out.

Thirteen Month Calendar (Positivist Calendar)

JANUARY							FEBRUARY							MARCH						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
8	9	10	11	12	13	14	8	9	10	11	12	13	14	8	9	10	11	12	13	14
15	16	17	18	19	20	21	15	16	17	18	19	20	21	15	16	17	18	19	20	21
22	23	24	25	26	27	28	22	23	24	25	26	27	28	22	23	24	25	26	27	28

In the above calendar each month is exactly alike; the thirteenth month, Sol, is placed between June and July. Year End Day is to be the extra day between December 28 and January 1; Comte suggested that this day be consecrated to "All the Dead" and Leap Year Day be dedicated to "Eminent Women."

World Calendar (Twelve Months)

JANUARY							FEBRUARY							MARCH						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7				1	2	3	4						1	2
8	9	10	11	12	13	14	5	6	7	8	9	10	11	3	4	5	6	7	8	9
15	16	17	18	19	20	21	12	13	14	15	16	17	18	10	11	12	13	14	15	16
22	23	24	25	26	27	28	19	20	21	22	23	24	25	17	18	19	20	21	22	23
29	30	31					26	27	28	29	30			24	25	26	27	28	29	30

In the world calendar each quarter is exactly like the first quarter; the first month has 31 days and the second and third months 30 days each. Leap Year Day is an extra day that

comes at the end of 26 weeks and Year Day at the end of 52 weeks.

THIRTEEN MONTH CALENDAR

ADVANTAGES

1. There is a symmetrical standard of time. Every month begins on Sunday.
2. Each month has twenty-eight days or four even weeks which exactly quarter each month.
3. Quarters and half years are preserved in weeks and few need or use other divisions such as a third or a sixth of a year.
4. Month ends coincide with week ends.
5. Number of days between any two dates are easily computed for salaries, rents, interest, etc. Saves time, money, and prevents mistakes. "An estimate made of such economies in the United States at clerk rates indicated a yearly saving of about \$30,000,000."²
6. Holidays are stabilized and put on Monday if possible.

DISADVANTAGES

1. Ninety-four days have to be transferred from one month to another.
2. A new month must be added.
3. Thirteen is a prime number and cannot be broken into factors; hence the quarter and half year, convenient units of time in terms of months, are dispensed with. Much business is done on the quarter and half year basis and a calendar that has only monthly divisions is not as useful as the present one. Salary, rent, dividends, interest, mortgage, and insurance, which are usually paid quarterly are affected. Many business concerns such as railways, banks, industries, utilities, governments, etc. issue reports and balance sheets half yearly.
4. The end of the month falls on Saturday which is already a heavy day. The sending of bills, checks, accounts, salaries, and taking inventories increase the load of that day and in the future five day work week it will probably be a holiday.
5. Monthly interest which is now computed on a 30 day basis would have to be computed on a 28 day basis or a $1/13$ of a year basis. Interest on \$1 for one month is .004615 + instead of the easy computation of $\frac{1}{2}$ cent per month on \$1 if the rate is 6 per cent per year.
6. There would be a loss of or change in anniversaries of various kinds, that for sentimental reasons, might not be desired.

² Julia E. Johnsen, Compiler: *The Reference Shelf*, New York: The H. W. Wilson Co., September 1929, pp. 121 ff.

ADVANTAGES

7. Statistical presentations of comparative reports are facilitated.
8. Monthly money now circulating 12 times a year would circulate 13 times and aid business.
9. Having an even distribution of time in each month aids in budgeting and in more accurate cost and production records.
10. Accounts and business transactions would always fall on week days.
11. Each day of the month would fall on the same day of the week every month. Pay days, rents, meetings, etc., would occur on the same monthly dates, the regularity of which is a great advantage in the home and business. Day and date could be recorded on watches and clocks.
12. Monthly and yearly calendars could be perpetual and could be used indefinitely.
13. It is easily memorized.

DISADVANTAGES

7. There might be some serious economic disturbance; for example, if employers cut monthly wages and landlords did not make rent reductions on the same basis.
8. Monthly activities such as meetings, paying bills, collecting statistics, would have to be done 13 times during the year instead of 12.
9. The year is divided into four seasons which cannot easily be arranged in a thirteen month calendar.
10. Astronomy uses the quarter as a basis.

WORLD CALENDAR

ADVANTAGES

1. The twelve month year is retained.
2. There are no split weeks in quarters or half years.
3. Thirty-one and thirty day months are uniformly arranged within the quarters.
4. Quarters and half years are retained and equalized. Each quarter begins on Sunday.

DISADVANTAGES

1. Months do not begin on the same day of the week throughout the year.
2. Split weeks in months are not eliminated.
3. The number of days in the month is not exactly the same but more nearly equal than in the Gregorian calendar.
4. The fifth Saturday of the third month of each quarter is not banished.

ADVANTAGES

5. There are thirteen complete weeks in each quarter.
6. The calendar is identical for every quarter of every year.
7. Each month has 26 working days.
8. Only 8 days are transferred from one month to another; that fact enables us to keep present dates without much change.
9. The inequality of the months is cut from three days to one day.
10. No new month is added.
11. Six months have the same number of days as now, (January, June, July, September, October, and November).
12. No date in the World Calendar has its date moved more than two days from the beginning of the year.
13. This plan is less drastic than the previous reform when July and August were added and 11 days were dropped by Pope Gregory XIII.
14. The saving in the business world calculations will be enormous.
15. Uniform size of months makes statistical computations comparable for all months of the year for all years. Eventually normal ratios can be established.
16. Christmas retains the same date, December 25, and always comes on Monday.
17. It is easily memorized.
18. It receives general approval in Europe.

DISADVANTAGES

POINTS OF SIMILARITY

1. Both calendars are based on a year of 364 days with Year End Day inserted between December 28 and January 1 and

THE UTILITARIAN CALENDAR

PERPETUAL CALENDAR GOOD FOR ANY YEAR																						Leap Day	Year Day									
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday			Galaday								
January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
February	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
March	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
August	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
September	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
October	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
November	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
December	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Year Day

Leap Year Day, according to the World Calendar, placed between June 30 and July 1, and in the thirteen month calendar between December 28 and January 1.

2. In 364 days there are exactly 52 weeks. All years may begin on Sunday and end on Saturday.

3. Inequality of the months is reduced or eliminated entirely.

4. Both calendars give absolute equality of the number of working days in a quarter.

5. Both make the year perpetual.

DIFFERENCES BETWEEN THE TWO CALENDARS

POSITIVISTS CALENDAR

1. Thirteen months of 28 days each.

2. No quarters corresponding to months.

3. Twenty-four working days per month.

4. No half years corresponding to months.

WORLD CALENDAR

1. Twelve months, one month of 31 days followed by two months of 30 days. Ninety-one days for each quarter of three months.

2. Half years 182 days each. (In Gregorian calendar there are 181 or 182 days in the first half and 184 in the second half.)

3. Four quarters of 91 days each begin on Sunday and end on Saturday. (In the Gregorian calendar the quarters are 90 or 91, 91, 92, 92, days respectively.)

4. Twenty-six work days per month.

There is a third proposal for a calendar change advocating that the year be divided into 12 months, each quarter of 91 days into two short months of 28 days each and one long month of 35 days; all months begin on Sunday and end on Saturday. This proposal necessitates little change in dates. The average change for any one date would be only two days and the greatest change four days. March, June, September, and December would have 35 days and the other months 28 days. The New Year Day and the Leap Year Day could come in this calendar at the end of the year. All business done on the week or quarter basis would find this plan advantageous.

A fourth plan, the Utilitarian Calendar, is that suggested by Rufus E. Chapin.³ The 23rd of March, June, September, and December are holidays following the change of the seasons.

³ Rufus F. Chapin, "Let's Improve Our Calendar," *The Rotarian*, vol. 46, January 1935, p. 26.

The nations of the world are expected to distribute their holidays in the other galadays indicated in the calendar.

CONCLUSION

The thirteen month calendar seems to be more convenient with regard to statistics and trade if the month is to be used instead of the quarter as the unit of time; the twelve month calendar is preferable if the quarter instead of the month is used. Various governments, commercial organizations and educational authorities seem to approve the twelve month calendar because of less disturbance in change. On the other hand many government and commercial authorities favor the thirteen month plan. The difficulty of adjustment may not be as great as some anticipate when it is recalled that about 300 millions of people in Asia, Africa, and Eastern Europe have changed with ease to the Gregorian calendar since the World War. It seems to be the opinion of some that indifference is the only obstacle to calendar reform.

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PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution as on the following pages.

The editor of the department desires to serve its readers by making it interesting, and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

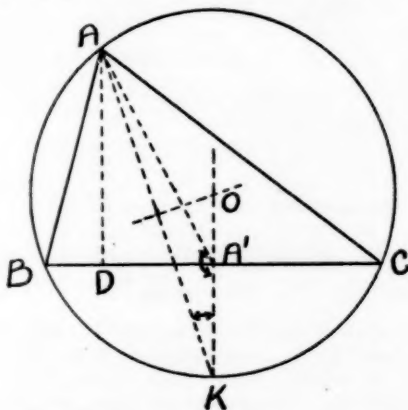
SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India Ink should be on a separate page from the solution.
2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.
3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1533. *Edward C. Varnum, D. L. MacKay.*
1536. *Daniel Finkel, New York, Edward C. Varnum, Clyde, Ohio, D. L. MacKay, New York.*
1537. *D. L. MacKay.*
1538. *Proposed by William W. Taylor, Port Arthur, Texas.*



Construct the triangle, given the difference of the base angles, the difference of the angles made by the median to the base, and the difference of the exradius relative to the base and the inradius.

Construction: Draw the line $A'K$ equal to one-half the given difference of the radii. At K construct $\angle A'KA$ equal to one-half the given difference of the base angles and at A' construct angle $KA'A$ supplementary to one-half the given difference of the angles formed by the median to the base. Since the sides of these two angles meet in A erect the perpendicular bisector of AK and meeting KA' produced in point O . Then with O as a center and radius OK describe a circle. At A' draw the perpendicular to $A'K$ and cutting the circle in points B and C . Draw AB and AC . Triangle ABC is the required triangle.

Proof: Draw the altitude AD .

$A'K = \frac{1}{2}(r' - r)$ (See *College Geometry*—Altshiller-Court, page 73)

$$\angle A'KA = \frac{1}{2} \angle DAO = \frac{1}{2}(B - C) \text{ (See } \textit{College Geometry}$$
—Altshiller-Court, page 53)

$$\angle OA'A = \angle A'AD.$$

But $\angle A'AD + 90^\circ = \angle CA'A$

$$90^\circ - \angle A'AD = \angle BA'A$$

By subtraction we have

$$2\angle A'AD = \angle CA'A - \angle BA'A$$

$$\angle A'AD = \frac{1}{2}(\angle CA'A - \angle BA'A).$$

Solutions were also offered by D. L. MacKay, D. F. Wallace, David K. Garlan, New York, and H. R. Mutch.

1539. *Proposed by Walter R. Warne, New York University.*

Solve for x :

$$(1+x+x^2)^2 = \frac{a+1}{a-1}(1+x^2+x^4).$$

Solution by David Gordon, Murray Hill High School, N. Y. C.

The factors of $1+x^2+x^4$ are $(1+x+x^2)(1-x+x^2)$.

Divide through by $1+x+x^2$ giving

$$(1) \quad 1+x+x^2=0, \quad \text{whence} \quad x = \frac{-1 \pm \sqrt{-3}}{2}.$$

$$\text{Also (2)} \quad 1+x+x^2 = \frac{a+1}{a-1}(1-x+x^2)$$

$$(3) \quad \frac{1+x+x^2}{1-x+x^2} = \frac{a+1}{a-1}$$

$$(4) \quad \frac{1+x^2}{x} = \frac{a}{1} \quad (\text{Composition and Division})$$

$$(5) \quad x^2 - ax + 1 = 0 \quad \therefore \quad x = \frac{a \pm \sqrt{a^2 - 4}}{2}.$$

EDITOR'S NOTE: Several people failed to offer the solutions of

$$x^2 + x + 1 = 0.$$

Solutions were also offered by Julius H. Hlavaty, N. Y. C., D. L. MacKay, New York, G. J. Leies, Dayton, Ohio, Edward C. Varnum, Clyde Ohio, Daniel Finkel, New York, Kenneth P. Carlson, Brule, Nebraska, A. MacNeish, Chicago, Alvin Mars, Brooklyn, N. Y., Alfred Engelbrecht, Waverly Ia., Walter Pressman, Charles W. Trigg, Los Angeles, David Rappaport, Chicago, Robert Becner, Centralia Township High School, Ethel Cain, Perry, Iowa, Aaron Buchman, Buffalo, H. R. Mutch, and the proposer.

1540. *Proposed by Aaron Buchman, Buffalo, N. Y.*

Given a variable triangle, ABC , which is similar to a given fixed triangle MNO . If A is fixed, and if B traces a circle, find the locus of C .

Solution by D. L. MacKay, New York, N. Y.

The ratio $AB:AC$ is a known constant and angle BAC is also a known constant.

Let vertex B describe the given circle D and draw AE so that $\angle DAE = \angle BAC$ and $AD:AE = AB:AC$. Then $\triangle BAD \sim \triangle CAE$ and $CE:BD = AC:AB$, whence, $CE = \frac{BD \cdot AC}{AB}$, a constant. Since point E is a fixed point, the locus of C is the circle E .

A solution was also offered by David Gordon, Murry Hill High School, New York City.

1541. Proposed by Maxwell Reade, Brooklyn, N. Y.

What is the relation between the sides, and that between the angles of a triangle whose Euler line, the line containing orthocenter, median point, and circumcenter, is parallel to one of the sides of the said triangle?

Solution by Charles W. Trigg, Eagle Rock H. S., Los Angeles.

In the triangle ABC , using the conventional notation, the area,

$$\Delta = \sqrt{s(s-a)(s-b)(s-c)} = \frac{1}{2}bh_b = \frac{abc}{4R} = rs = r_b(s-b)$$

where $2s = a + b + c$.

$$\tan \frac{1}{2}A = \frac{\Delta}{s(s-a)}, \quad \text{so} \quad \tan A = \frac{2 \tan \frac{1}{2}A}{1 - \tan^2 \frac{1}{2}A} = \frac{4\Delta}{b^2 + c^2 - a^2},$$

and two other similar expressions.

Let the Euler line which contains the orthocenter H , the centroid M and the circumcenter O be parallel to AC . Clearly the triangle must be acute. From the position of the centroid on a median and the properties of parallel lines, $ON = HK = \frac{1}{3}BK = \frac{1}{3}h_b = \frac{2}{3}\Delta/b$, where K is the foot of the altitude from B .

The distance from the circumcenter to AC is

$$ON = R - \frac{1}{2}(r_b - r) = \frac{abc}{4\Delta} - \frac{1}{2}\left(\frac{\Delta}{s-b} - \frac{\Delta}{s}\right) = \frac{abcs(s-b) - 2\Delta^2b}{4\Delta s(s-b)}.$$

Substituting and simplifying, $3ab^2cs(s-b) - 6\Delta^2b^2 = 8\Delta^2s(s-b)$, which eventually reduces to $(a^4 + c^4 - 2b^4) + (a^2b^2 + b^2c^2 - 2a^2c^2) = 0$. This, or one of the other two similar expressions, gives the relationship between the sides if the Euler line is parallel to a side.

This condition may also be written in the form,

$$2[b^4 - (a^4 - 2a^2c^2 + c^4)] = c^4 - a^4 + 2a^2b^2 - b^4 + a^4 - c^4 + 2b^2c^2 - b^4.$$

When this is multiplied through by

$$4\Delta/(a^2 + b^2 - c^2)(b^2 + c^2 - a^2)(c^2 + a^2 - b^2)$$

we secure

$$\frac{2(4\Delta)}{c^2 + a^2 - b^2} = \frac{4\Delta}{a^2 + b^2 - c^2} + \frac{4\Delta}{b^2 + c^2 - a^2}.$$

That is, $2 \tan B = \tan C + \tan A$. So, if the Euler line is parallel to a side of a triangle, the tangents of the angles form an arithmetic progression, whose mean is the tangent of the angle opposite the side to which the line is parallel.

The proof of the converse of this proposition appeared in the *Ameriean Mathematical Monthly*, E259, page 541, October 1937. Hence the relationship is necessary and sufficient.

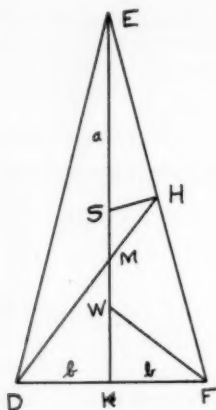
Solutions were also offered by August Weiss, Brenham, Texas, and D. L. MacKay, New York.

1542. Proposed by H. Brandt, Chicago.

In an isosceles triangle with base $2b$, and altitude a , prove that

$$WM = MS = \frac{2a}{15}, \quad \text{where } M \text{ equals the point of concurrence of the medians;}$$

W the point of concurrence of the angle bisectors, and S the point of concurrence of the three perpendicular side-bisectors.



Solution by Charles W. Trigg, Eagle Rock H. S., Los Angeles.

In the isosceles triangle DEF with base $DF = 2b$, let K and H be the midpoints of DF and EF , respectively. The altitude, median and angle bisector from the vertex of an isosceles triangle coincide with the perpendicular bisector of the base, so the centroid M , incenter W and circumcenter S fall on $EK = a$.

$$EH = \frac{1}{2}\sqrt{a^2 + b^2} \quad \text{and} \quad \triangle ESH \sim \triangle EKF, \quad \text{so}$$

$$ES:EH::EF:EK. \quad \text{Hence} \quad ES = \frac{a^2 + b^2}{2a}.$$

$$EM = \frac{2}{3}EK = \frac{2}{3}a.$$

$$MS = \pm (EM - ES) = \pm \frac{a^2 - 3b^2}{6a}.$$

So if MS is to equal $\frac{2a}{15}$, then $a = b\sqrt{15}$ or $a = \frac{b\sqrt{15}}{3}$.

$$WK = r = \frac{\Delta}{s} = \sqrt{\frac{b \cdot b \cdot (\sqrt{a^2 + b^2} - b)}{\sqrt{a^2 + b^2} + b}} = \frac{b}{a}(\sqrt{a^2 + b^2} - b).$$

$$WM = \pm [(EK - WK) - EM] = \pm \frac{a^2 + 3b^2 - 3b\sqrt{a^2 + b^2}}{3a}.$$

If $a = b\sqrt{15}$, then WM reduces to $\frac{2a}{15}$, which it does not do for $a = b\sqrt{15/3}$. Therefore the proposition is true if and only if $a = b\sqrt{15}$.

It will be observed that if the triangle is equilateral, whence $a = b\sqrt{3}$, the fundamental formulas for MS and WM reduce to zero, as they should, since in this case M , W and S coincide.

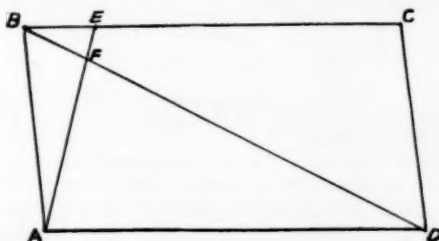
A solution was also offered by the proposer.

1543. *Proposed by Charles P. Louthan, Columbus, Ohio.*

From vertex A , of parallelogram $ABCD$ a straight line is drawn cutting BC in E and diagonal BD in F . If $BE = BC/n$, prove that $BF = BD/n + 1$.

Using alternate-interior and vertical angles, it is easily shown that triangle BEF is similar to triangle DAF , from which $AD/BE = FD/BF$. Inasmuch as $AD = BC$, $BE = BC/n$, and $DF = BD - BF$, we have, by sub-

stitution $BC \div (BC/n) = (BD - BF) \div BF$. $nBF = BD - BF$. $(n+1)BF = BD$. $BF = BD/(n+1)$.



Solution by Edward C. Varnum, Clyde, Ohio.

Solutions were also offered by G. John Leies, Dayton, Ohio, D. L. MacKay, New York, Daniel Finkel, New York, Kenneth P. Carlson, Brule, Nebraska, A. MacNeish, Chicago, David Gordon, Murray Hill High School, N. Y. C., H. R. Mutch, Walter R. Warne, N. Y. C., Walter Pressman, D. F. Wallace, Charles W. Trigg, Los Angeles, Aaron Buchman, Buffalo, and Norman Greenspan.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

1526. *Eli Perry, Simon Gratz High School, Philadelphia.*

1539. *Cecil Leith, Scituate, Mass., Eli Perry, Simon Gratz High School Philadelphia, Robert S. Moore, Girard College, Philadelphia.*

1533. *Robert Beaver, Centralia, Ill.*

1543. *Cecil Leith and Ernest Barbuto, Scituate, Mass.*

PROBLEMS FOR SOLUTIONS

1556. *Proposed by Max Lipshitz, Bayonne, N. J.*

Locate on BC , CA , AB of the triangle ABC the points P , Q , R , respectively such that

$$\frac{BP}{BC} = \frac{CQ}{AC} = \frac{AR}{AB} = \frac{1}{n}.$$

Show that the area of triangle

$$PQR = \frac{n^2 - 3n + 3}{n^2}$$

times are a triangle ABC , if n is an integer.

1557. *Proposed by Charles W. Trigg, Los Angeles.*

Find a square number of the form $abcdefgh$ such that $gh = k(ab)$ and cd and ef are square numbers.

1558. *Proposed by Waller R. Warne, New York City.*

Eliminate x and y from the equations: (If possible, secure a solution involving no radicals at any place.)

$$x + y = a$$

$$x^3 + y^3 = b^3$$

$$x^4 + y^4 = c^4.$$

1559. *Submitted by the editor.*

At the vertices A , B , and C , of an equilateral triangle, each side being 600 ft. in length, towers a , b , c , with $a = 30$, $b = 40$, $c = 50$ in height respectively are erected. Where in the plane of the triangle must the foot of the ladder be placed, so that turning about its base, F , it will exactly reach the top of each tower. Also find the height of the ladder.

1560. *Proposed by Dewey C. Duncan, Compton, Calif.*

Find the sum of the squares of the distances of the vertex of the right angle from the points of trisection of the hypotenuse. (See Altshiller-Court's *College Geometry*, page 114, problem 3.)

1561. *Proposed by William W. Taylor, Port Arthur, Texas.*

In the triangle ABC , locate M and N on AB and BC respectively such that MN has a given direction and is equal to the sum of MB and CN .

SCIENCE QUESTIONS

May, 1938

Conducted by Franklin T. Jones, 10109 Wilbur Avenue,
Cleveland, Ohio

Please send copies of Tests and Examinations to Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

Send your most interesting question in Biology, Chemistry, General Science, or Physics. Join the GQRA (Guild Question Raiser & Answers). Have your class answer or propose a problem or question.

NOW 230 MEMBERS IN THE GQRA

HOW FAST?

839. *From a newspaper clipping.*

What is the fastest living creature?

How fast can it travel?

CONGRESS AND THE INCH

840. *How long is the American inch?*

The English inch?

Why the difference?

How correct it?

REGENTS' EXAMINATION IN CHEMISTRY

841. *271st High School Examination—University of the State of New York. Answer all questions in part I and any five questions from part II. Answers to the questions in part I should be written on the question paper as directed*

and handed in with the other answer paper. Answers should be numbered and lettered to correspond with the questions.

PART I

Answer all questions in part I

Write after *each* of the numbers at the right the word or expression which, if inserted in the corresponding blank, will make the statement true. [20]

1. If ..(1).. is heated with concentrated sulphuric acid, sulphur dioxide will be set free. 1.....
2. Dilute sulphuric acid, reacting with ..(2).., will produce hydrogen. 2.....
3. The ..(3).. theory was formulated by Dalton and is based on the laws of definite and multiple proportions. 3.....
4. Manganese dioxide used with ..(4).. acts as an oxidizing agent. 4.....
5. Manganese dioxide used with ..(5).. acts as a catalytic agent. 5.....
6. "Equal volumes of gases under the same conditions contain the same number of molecules" is a statement credited to ..(6).. 6.....
7. The evaporation of a solution of sulphur in carbon disulphide forms ..(7).. sulphur. 7.....
8. An acid ..(8).. is an oxide that unites with water to form an acid. 8.....
9. Gases escaping from automobile storage batteries cause corrosion of metal parts because they carry with them small particles of ..(9).. acid. 9.....
10. Litmus paper moistened with a solution containing OH ions will become ..(10).. 10.....
11. The reaction between zinc sulphide and ..(11).. will go to completion because a volatile product is formed. 11.....
12. ..(12).. is the gas used with hydrogen in the Haber process. 12.....
13. Oxygen and ..(13).. unite in the presence of a catalyst in the preparation of sulphuric acid by the contact process. 13.....
14. Hall discovered the process by which ..(14).. may be prepared from its ore. 14.....
15. When carbon monoxide burns in air, ..(15).. is formed. 15.....
16. A gas used to destroy germs in swimming pools and in water is ..(16).. 16.....
17. Bromine will replace ..(17).. from its compounds. 17.....
18. Water gas is poisonous to inhale because it contains ..(18).. 18.....
19. A compound of carbon that may be used to sharpen tools is ..(19).. 19.....
20. Coke is produced by the destructive distillation of ..(20).. 20.....

Write on the line at the right of *each* statement the number preceding the word or expression that makes the statement true. [20]

21. Blowing on a candle flame puts out the fire because the breath (1)lowers the temperature below the kindling point (2)blows away the oxygen (3)contains no oxygen
22. A substance that will be a nonelectrolyte when dissolved in water is (1)sodium nitrate (2)alcohol (3)vinegar
23. Water can be made chemically pure by (1)boiling (2)filtration (3)distillation
24. Zinc chloride solution is an electrolyte because it contains (1)ions (2)zinc (3)atoms
25. Air contains (1)one fifth (2)four fifths (3)one half nitrogen.
26. The arc process is a method of producing (1)sulphuric acid (2)nitric acid (3)ammonia
27. The percentage of carbon in the product made in the open-hearth process is (1)greater than (2)less than (3)the same as the percentage of carbon in pig iron.
28. If a bottle of concentrated sulphuric acid is allowed to stand open to the air, the level (1)rises (2)falls (3)remains the same
29. When copper oxide and charcoal are heated together, a gas is formed that will (1)produce a red color (2)form a white precipitate (3)cause no change if allowed to pass through lime-water.
30. If chlorine replaces bromine in a solution of a bromide, the bromine (1)gains electrons (2)loses electrons (3)neither gains nor loses electrons
31. The chemical composition of marble is the same as that of (1)limestone (2)granite (3)firebrick
32. Water containing (1) $\text{Ca}(\text{HCO}_3)_2$ (2) CaSO_4 (3) $\text{Mg}(\text{HCO}_3)_2$ is permanently hard.
33. Plaster of Paris is made by removing (1)oxygen (2)carbon dioxide (3)water from gypsum.
34. A tin can is made of (1)iron (2)aluminum (3)brass coated with tin.
35. Sodium should be stored in (1)air (2)water (3)kerosene
36. Brass is an alloy of (1)copper and zinc (2)tin and lead (3)copper and aluminum
37. A compound frequently used in mechanical refrigerators is (1) HNO_3 (2) NH_3 (3) NH_4Cl
38. Sulphur dioxide is used for (1)cleaning (2)dyeing (3)bleaching straw hats.
39. The formula of Chile saltpeter is (1) NaNO_3 (2) KNO_3 (3) Na_2CO_3
40. The atomic number of calcium is 20; its valence is (1)+1 (2)-1 (3)+2

In the parentheses at the right of *each* word or expression in column B write the number of the word or expression in column A that is most closely related to it. [10]

Column A

41. Curie
42. Lavoisier
43. chlorine
44. bromine
45. nitric oxide

Column B

- acetylene
produce carbon dioxide
a liquid element
theory of burning
radium

()
()
()
()
()

46. hydrogen sulphide	heavy yellowish-green gas	()
47. animals	produces SO_2 and H_2O on burning	()
48. dextrose	turns brown when exposed to air	()
49. acetic acid	glucose	()
50. cutting metals	vinegar	()

PART II

Answer any five questions from part II

- Using a labeled diagram, show how chlorine may be prepared and collected in the laboratory [3]. Name the materials used [1].
 - What chemical compound would remain in the generator when the reaction is completed? [1]
 - What change would you make in the apparatus and in your choice of chemicals if you wished to prepare and collect hydrogen? [2]
 - What soluble compound would remain in the hydrogen generator when the reaction is completed? [1]
 - Would either method of collection be suitable for ammonia? Give the reason for your answer. [2]
- Solve *two* of the following problems: [Show all work; no credit will be given for answer alone]. [Atomic weights: C = 12, Ca = 40, Fe = 56, H = 1, N = 14, O = 16, S = 32] [One liter of carbon dioxide weighs 1.98 grams.]
 - How many liters of carbon dioxide go up the chimney during the complete combustion of 1000 grams of coal that is 75% carbon? [5]
 - A solution containing 147 grams of nitric acid was spilled on the floor. How many grams of calcium hydroxide were necessary to neutralize this acid? [5]
 - To produce ferrous sulphide, 140 grams of sulphur were heated with 182 grams of iron. How many grams of sulphur were left uncombined? [5]
- Select from the following one reaction that does not go to an end [2] and write balanced equations for four that do [8].
 - $\text{Na}_2\text{SO}_3 + \text{H}_2\text{SO}_4 \rightarrow$
 - $\text{K}_2\text{SO}_4 + \text{Ba}(\text{OH})_2 \rightarrow$
 - $\text{CuSO}_4 + \text{HCl} \rightarrow$
 - $\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \rightarrow$
 - $\text{KCl} + \text{I}_2 \rightarrow$
 - $\text{H}_3\text{PO}_4 + \text{Ca}(\text{OH})_2 \rightarrow$
- Applying your knowledge of the electron theory, show by labeled diagrams the difference in structure between an atom of lithium, an ion of lithium and an atom of helium. [3]
 - In terms of the ionic theory explain
 - The difference between a base and an acid [2]
 - Why dilute sulphuric acid would attack steel tank cars while concentrated sulphuric acid would not [2]
 - The atomic weight of hydrogen is 1 and the atomic weight of helium is 4. Explain why a liter of helium is only twice as heavy as a liter of hydrogen. [3]
- The tests for identifying certain compounds are described below. Name the compound that is indicated in each of *five* of the following: [10]
 - The material yields a green color in the cobalt nitrate test and, when mixed with chlorine water and carbon bisulphide, produces a reddish-brown color.
 - The solution gives off the odor of ammonia when heated with a

- base, and forms with silver nitrate a white precipitate insoluble in nitric acid.
- c. The solution colors the Bunsen flame yellow and, when mixed with chlorine water and carbon disulphide, produces a purple color.
 - d. The solution colors the Bunsen flame violet and, when treated with hydrochloric acid, gives off a gas that turns limewater milky.
 - e. The solution produces a yellow precipitate with potassium chromate, and with concentrated sulphuric acid and ferrous sulphate yields a brown ring.
 - f. The solution colors the Bunsen flame greenish yellow and, when heated with hydrochloric acid, gives off a gas that blackens moist lead-acetate paper.
6. a. (1) Name *three* alloys that could be made if supplies of silver, copper, tin, lead, antimony and aluminum were available and mention the metals used in *each* alloy. [3]
 (2) State a use for *each* alloy. [3]
 - b. Two glass bottles are completely filled, one with wet lime mortar, the other with wet cement concrete and both tightly stoppered. Explain why the concrete will harden while the other will not. [2]
 - c. A boy in his home laboratory has HCl , MnO_2 , KClO_3 , NaI , Na_2CO_3 and H_2SO_4 . He wishes to prepare *iodine*. Name the chemicals used, and describe the procedure briefly. [2]
7. a. Select *five* of the following products and give for each the principal substances used in its manufacture: cement, quicklime, glass, pig iron, baking soda, bleaching powder. [5]
 b. Name the chief commercial product for each of *five* of the following: Solvay process, open-hearth process, Frasch process, Haber process, cracking process, flotation process. [5]
 8. a. Compare carbon and nitrogen by furnishing the following information:
 - (1) Give the formula and name of *one* binary compound of each with hydrogen. [2]
 - (2) Give the formula and name of an acid of each. [2]
 - (3) Give the formula and name of an acid anhydride containing each element. [2]
 - b. (1) How may sugar be changed to alcohol? [1]
 (2) Give name and formula of a sugar often used for the purpose mentioned in b (1). [1]
 (3) How may an acid be formed from an alcohol? [1]
 (4) Name the compounds used by plants in the formation of starch. [1]

THE HINDENBURG DISASTER

802. From the newspapers.

Why did not the Hindenburg use helium gas and thus avoid this terrible disaster?

How much hydrogen gas did the Hindenburg carry?

How much did the ship weigh?

What pay load could it carry?

Why or why not take a Zeppelin to Europe? (Limit 10 lines)

Answer by Charles Estes (Elected to the GQRA No. 228) Franklin High School, Portland, Oregon. Endorsed by A. Neikirk (Elected to the GQRA No. 231). Chemistry Teacher, Franklin High School.

(I took most of this information from a naval record book.)

The "Hindenburg" did not carry helium instead of hydrogen on its fateful crossing of the Atlantic because mainly of three reasons: first, is the fact that helium cost too much at the time; second, that there was a limited supply of helium in Germany at the time; and third, they had to have as much lifting power as possible because of the weight they were carrying. On its fateful voyage across the Atlantic the Hindenburg carried 7,360,000 cu. ft. of hydrogen. The ship weighed 220 tons not counting passengers and their luggage (approximately). The pay load weighed approximately 4900 lbs.

If the Zeppelin has been tested and is using helium I see no reason why it should not be used for transportation to Europe because there is the same danger in traveling by airplanes, which so many people use.

THE MADGEBURG HEMISPHERES

819. *Question and Comments by James A. Lemon, GQRA No. 142, Eaton High School, Eaton, Ohio.*

"How many horses were used to separate the Magdeburg hemispheres?"

"In my work in General Science the subject of the Magdeburg hemispheres has naturally been stressed as an example of the force of air. My reference sources have given me contradictory facts concerning the number of horses used by Otto von Guericke in his experiment with the Magdeburg hemispheres."

(What information have our readers on this subject? Send in the information as you find it and then we will try to go back into history far enough to find out.

It might be worth while for some of our mathematically inclined physicists to take the size of the hemispheres, the expected pull of a team of horses, and then check up on the reasonableness of the number of horses sometimes represented in descriptions of this experiment. EDITOR.)

Comment by F. H. Wade (GQRA No. 205), Lewis Institute, Chicago.

On page 87, *Practical Physics*, Black and Davis, 1st ed., there is a copy of a very old engraving showing the original Magdeburg hemispheres and the original experiment performed by Otto von Guericke. This shows 8 horses on one end and 8 horses on the other end. The student may then be asked "How many horses all together?" and the answer of course is Eight. The old Nestor Otto knew this well enough, but 16 horses make a better show.

In looking through some old records I find that J. N. Wheeler of St. Charles, Ill., April 1917 put a spring balance in one trace of his team on a scoop and found that the maximum tractive effort was $590 \times 4 = 2360$ pounds for the team.

Considering that von Guericke's teams were just as good, the pull on the hemispheres was 4 teams $\times 2360$ or 10,446 pounds.

Giving the hemispheres credit for a good vacuum of say 29", their diameter would have to be around 30" and this is just about what the picture shows.

THE TALON OF THE "GENEVA FREE PRESS"

Through co-operation between Mr. C. A. Bonsor (GQRA, No. 126), Editor of the GENEVA FREE PRESS and Member of the Geneva Board of Education, Mr. D. R. Frasher, Superintendent of Schools, and the Teachers and Pupils of Geneva High School, the editorial page of the FREE PRESS is turned over to the High School staff of the "TALON" every Wednesday.

Editorials are written by students, news of the school is sent out to the entire community, interesting questions are asked and answered.

832. Question—Is a similar practice carried on in other communities? If so, where? (Please send copies containing such a department to the Editor of SCIENCE QUESTIONS.)

Answered by Miss Eugenia Zima, Editor of the TALON (Elected to the GQRA, No. 229) and Miss Sara L. Gough, Faculty Adviser. (Elected to the GQRA, No. 230), both of Geneva, Ohio.

By Eugenia Zima, GRQA No. 228.

My dear Mr. Jones:

Your have given the *Talon* great motivation by your recognition. It has made the staff realize that their work goes beyond the school and the Village, and due to this fact they must be more careful with the material that they print.

We could be much happier about the recognition if it had not included a humiliation. "Just Bones" belongs to Paul G. Glenister, Chicago—age 14. It was copied from Robert Ripley's column in an October issue of the *Sunday Cleveland Plain Dealer*.

I wanted to give the pupil who submitted it to us credit after his article had appeared in your magazine. When he was located he readily admitted that it was copied from Ripley and didn't seem to realize that he had done anything wrong.

The incident has made a splendid lesson in every one of our English classes.

By Sarah L. Gough, GQRA No. 229.

The *Talon*, the Geneva High School newspaper, Geneva, Ohio, is published every Wednesday in the local daily paper, *The Geneva Free Press*.

The page carries the names of the student-staff and the name of the paper and its own mast head. The *Talon*—the eagle's claw—is used, because the eagle is the symbol of the school.

The student-staff is entirely responsible for what goes on the page, except for head lines, balance, and advertisements. No copy is re-edited. The copy reading is done by the *Free Press*. The copy is sent to press Tuesday, at 4:30 P.M. dead-line.

This manner of issuing a school publication has decided advantages.

(1) School news is carried to the community at large and not just into homes where children are in school, or where children are fortunate enough to be able to subscribe to the school paper and the local paper.

(2) It gets the pupils in the habit of reading the local daily, and in some cases increases the subscribers.

(3) It is an advantage to out-of-town college students and alumni of the high school who like to keep in contact with the school and village, and can do so by subscribing to only one paper.

(4) It enables the Superintendent and Principal to get their messages before the general public.

(5) It makes it possible to issue it more frequently, therefore the news is more timely, which is a general criticism of the average high school paper.

(6) And of paramount importance is the elimination of the financial worries which beset the high school paper. There are no subscription campaigns, and no soliciting of advertising from harassed merchants.

Of course there are some disadvantages. For instance:

(1) Our village is small and the daily likes to use the school sports on the sports page. That eliminates sports on the school page except for the student sports column.

(2) The reporters on the daily frequently scoop news from our office which appears on the front page rather than on our sheet.

(3) The student-staff gets no training in head-lines, balance, art, advertising copy, or the business end of journalism.

However we find that the advantages far outweigh the disadvantages. And we realize the advantage of having a daily paper in a village so small that our news is of sufficient interest to the general public to warrant its being published in the daily paper.

I am not aware of any other high school publication which is published in this manner. There are a great many schools which run columns of school news in the local daily; but they neither have a regular space nor set time.

GQRA OUTING AT PEN' BRYN-ON-LAKE ERIE

On July 31, 1938, (Sunday) all members and their friends of the Guild of Question Raisers and Answerers are invited to meet at PEN' BRYN with the EDITOR OF SCIENCE QUESTIONS. PURPOSE: an exchange of ideas and the promotion of acquaintanceship. Come!!!

BOOKS AND PAMPHLETS RECEIVED

Essentials of Engineering Mathematics, by J. P. Ballantine, Professor of Mathematics, University of Washington, Seattle, Washington. Cloth. Pages xi + 502 + 76. 15 × 23 cm. 1938. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price \$3.75.

Our Ferns, Their Haunts, Habits and Folklore, by Willard Nelson Clute, Editor of *The American Botanist*. Second Edition. Cloth. Pages xx + 388. 14 × 20 cm. 1938. Frederick A. Stokes Company, 443-449 Fourth Avenue, New York, N. Y. Price \$4.00.

Through by Rail, by Charles Gilbert Hall. Cloth. 152 pages. 15 × 23.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$1.32.

College Algebra, by William L. Hart, Professor of Mathematics, University of Minnesota. Revised Edition. Cloth. Pages viii + 408 + 30. 13.5 × 19.5 cm. 1938. D. C. Heath and Company, 285 Columbus Avenue, Boston, Massachusetts. Price \$2.24.

Excursion in Mathematics, by Ernst R. Breslich, Associate Professor of the Teaching of Mathematics, The Department of Education, and Head of the Department of Mathematics, The University High School, The University of Chicago. Cloth. 47 pages. 20 × 23 cm. 1938. The Orthovis Company, 1328 South Wabash Avenue, Chicago, Ill. Price \$1.20.

A Story of Water, by Augustus Pigman. Cloth. Pages xii + 151. 12.5 × 19 cm. 1938. D. Appleton-Century Company, 35 West 32nd Street, New York, N. Y. Price \$1.50.

A First Course in Physics for Colleges, by Robert Andrews Millikan, Director of the Norman Bridge Laboratory of Physics, Pasadena, California; Henry Gordon Gale, Professor of Physics in the University of Chicago; and Charles William Edwards, Professor of Physics in Duke University. Revised Edition. Cloth. Pages xiii + 712 + lxii. 13.5 × 21.5 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price \$4.00.

Plane Trigonometry, by Clifford N. Mills, Professor of Mathematics, Edith I. Atkin, Associate Professor of Mathematics, and Elinor B. Flagg, Assistant Professor of Mathematics, Illinois State Normal University,

Normal, Ill. Cloth. Pages xii + 170. 15 × 22 cm. 1937. Scott, Foresman and Company. Price \$1.60.

Radio, A Study of First Principles, by Elmer E. Burns. Third Edition. D. Van Nostrand Company, 250 Fourth Avenue, New York, N. Y.

Aluminum, by Douglas B. Hobbs. Cloth. Pages viii + 295. 14.5 × 23 cm. 1938. The Bruce Publishing Company, 524-544 N. Milwaukee Street, Milwaukee, Wisconsin. Price \$3.00.

Emotion and the Educative Process, by Daniel Alfred Prescott, Professor of Education, Rutgers University. Cloth. Pages xviii + 323. 15 × 23 cm. 1938. American Council on Education, 744 Jackson Place, Washington, D. C. Price \$1.50.

Experience Units in Biology, by J. Frank Faust, Principal Chambersburg High School, Chambersburg, Pennsylvania, and George R. Biecher, Head Teacher of Biology, Chambersburg High School, Chambersburg, Pennsylvania. Cloth. Pages x + 404. 13.5 × 19 cm. 1938. Stackpole Sons, Cameron and Kelker Streets, Harrisburg, Pa. Price \$1.60.

Biology for Life, by Harold U. Cope, Teacher of Biology, Union High School, Upper Sandusky, Ohio, and Edwin Lincoln Moseley, Professor Emeritus of Biology, Bowling Green State University, Bowling Green, Ohio. Paper. Pages viii + 312. 19.5 × 27 cm. 1938. Price 72 cents.

The Rockefeller Foundation, A Review for 1937, by Raymond B. Fosdick, President of the Foundation. Paper. 62 pages. 15 × 23 cm. 1938. New York, N. Y.

Chemistry Achievement Test, by Earl R. Glenn, New Jersey State Teachers College at Montclair, and Louis E. Welton, John Hay High School, Cleveland, Ohio. Test 1, Form A and Form B; Test 2, Form A and Form B. Each Test of 12 pages is sold in packages of 25 examinations of either Form A or B, with Manual of Directions, Key, and Class Record in each package, transportation additional. Price per package \$1.30.

Instruments of Precision, Catalog M-138. Paper. 66 pages. 21.5 × 28 cm. 1938. The Gaertner Scientific Corporation, 1201 Wrightwood Avenue, Chicago, Ill.

A Handbook on Nature Trails, by William G. Vinal, Professor of Nature Education, Massachusetts State College, Amherst, Mass. Paper. 8 pages. 13 × 21.5 cm. 1938.

BOOK REVIEWS

Plane Trigonometry, by Clifford N. Mills, Professor of Mathematics, Edith I. Atkin, Associate Professor of Mathematics, Elinor B. Flagg, Assistant Professor of Mathematics, Illinois State Normal University. Cloth. Pages xii + 170. 15 × 22 cm. 1937. Scott, Foresman and Company. Price \$1.60.

This little volume is a noteworthy contribution to the presentation of trigonometry on a level appropriate to students in the senior high school and the junior college. Its authors have given unusual attention to pedagogical considerations. We note the following features.

1. As an introduction to each of the nine chapters we find a page devoted to the history of the material treated in that chapter.
2. In the first four chapters emphasis is placed on indirect measurement. The student through a wealth of interesting problems is led to see the practical nature of the subject.
3. The authors present the exposition in a form which students can read with understanding.

4. In the introduction of new relationships the geometrical approach is employed.

5. One difficulty is presented at a time. For example, the student is given the opportunity of using the natural functions in solving both right and oblique triangles before the introduction of logarithms.

6. By presenting the general definitions of the trigonometric functions near the beginning the student is spared the task of having to make the adjustment from the special to the general definitions.

7. There is a generous supply of exercises with spread in difficulty to satisfy the needs of students at various levels of ability.

8. There are four place tables of the natural trigonometric functions, logarithms of numbers, and logarithms of trigonometric functions.

9. The typography is a work of art.

In the opinion of the reviewer the book will enjoy extensive adoptions.

J. M. KINNEY

Calculus, by Herman W. March, Ph.D., Professor of Mathematics, University of Wisconsin, and Henry C. Wolff, Ph.D., Professor of Mathematics, Drexel Institute of Technology. Third Edition. Pages xvii + 424. 12.5 × 18.5 cm. 1937. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price \$2.50.

In this third edition the authors have rewritten a considerable part of text. The general plan of the organization of the first edition remains. In this plan integration is introduced early. In fact we find it introduced on page 49. This arrangement makes it possible to introduce a large number of concrete applications of the calculus.

The authors hold to the belief that mathematics, and in particular calculus, is a mode of thought which may be applied to the study of scientific and technical problems. They believe that "The bond of union among the physical sciences is the mathematical spirit and the mathematical method which pervade them." In this book we find a manifestation of this belief carried to the nth degree.

J. M. KINNEY

Mathematics for Shop and Drawing Students, by Harry M. Keal, Head of Mathematics Department, Cass Technical High School, Detroit; and Clarence J. Leonard, Head of Mathematics Department, Southeastern High School, Detroit. Second Edition, pages vii + 225. 190 Figures. 13 × 18.5 cm. Cloth. List Price \$1.60. J. Wiley & Sons. New York. 1938.

As stated in the preface of this book, the purpose is to give to industrial workers and to students not going to college those parts of algebra, geometry, and trigonometry which would be most likely to occur in their technical work and study.

The arrangement is logical and sequential in the handling of above mentioned subject matter. Problems and exercises in the development of fundamentals are at a minimum, the emphasis being placed upon material gathered from sources common to the tradesman. In its simple and direct presentation it should appeal to the workman and the student that often has to move on his own. A working understanding of subject matter considered should facilitate in the mastery of algebra, geometry and trigonometry for college entrance.

The concluding chapter on the use of the slide rule may be introduced earlier at the convenience of the teacher as suggested by the authors. The appendix provides: Relations between the Trigonometric Functions, Formulas, Decimal Equivalents, Common Logarithms, and Logarithms of Trigonometric Functions.

LUMIR P. BRAZDA

Mathematics For Electrical Students, by Harry M. Keal, Head of Mathematics Department, Cass Technical High School, Detroit and Clarent J. Leonard, Head of Mathematics Department, Southeastern High School, Detroit. Second Edition, pages vii+225. 146 Figures. 13×18.5 cm. Cloth. List Price \$1.60. J. Wiley & Sons, New York.

In its organization this book closely parallels, *Mathematics for Shop and Drawing Students* by the same authors. Industrial workers and students not going to college that are especially interested in electrical problems will find the fundamentals of algebra, geometry and trigonometry that may be their need suitably presented.

There is an orderly handling of subject matter supplemented by problems related to topic under consideration. In keeping with the title, electrical examples are introduced as the mathematical background developed permits. The style of presentation makes it possible for students to advance with a minimum of assistance. It is reasonable to suppose that a grasp of fundamentals considered should enable one to complete algebra, geometry and trigonometry for college entrance more expeditiously.

The last chapter explains the use of the slide rule with examples for solution. The appendix provides: Relations Between Trigonometric Functions, Formulas, Decimal Equivalents, Logarithms, Logarithms of Functions, Natural Functions, Answers and Index.

LUMIR P. BRAZDA

New Analytic Geometry, Alternate Edition, by Smith, Gale, and Neelley. Cloth. Pages x+336. 1938. Ginn and Company.

The alternate edition of the authors *New Analytic Geometry* differs but little from the earlier edition in context. A few changes in notation and some additional worked examples constitute practically all the changes. However as the title alternate edition signifies most of the problems are new. Since the alternate edition differs so little from the first edition further comment seems unnecessary. The book is still a satisfactory text.

JOHN J. CORLISS

Chemistry (with some Geology) by J. A. Lauwerys B. Sc. Lecturer and Tutor in Methods of Science Institute of Education London and J. Ellison M. Sc. Senior Science Master Trinity County School N. 22. First Edition pp. xii+256. 13×19 cm. With numerous illustrations in line and half-tone. Cloth. 1938. Univ. of London Press Ltd. 10 & 11 Warwick Lane London E.C.4.

This new text is one of a series of general science texts of British origin. The two short introductory volumes of the series deal with science for the beginner and treat of matter and energy in an elementary way. They are followed by three larger volumes one on general biology, the present volume on chemistry with some geology and a final volume on physics (with passing reference to astronomy). The volumes are cross referenced, and correlation is attempted.

While a bit unsympathetic toward general science as it has too often been treated (with too much of educational theory and too little of the real spirit and method of science) the reviewer is bound to admit that there is not lacking abundant evidence of sanity in this little volume from abroad. The authors announce in their preface that while they "have paid much attention to industry and to the chemistry of everyday things" they "have also stressed the importance of general principles and have attempted as far as possible to fuse together practical and theoretical aspects."

Until one reaches chapter five there is little of innovation in the text for we find the authors dealing with air and combustion water and solutions and the composition of water. Next, earth is the topic and following that comes a chapter on minerals valuable to man. This subject is usually reserved for the later part of the conventional chemistry text but here we find some elementary metallurgy of copper, of iron and steel, and of some of the other common metals. Now we find the beginning of the theoretical chemistry teaching with the laws of chemical combination and an introduction to the atomic theory and to atomic weights. These last are handed out to the pupils and their method of determination is not explained. (The book is too brief for such exposition.) After more descriptive chemistry another section on theory presents the Gay-Lussac Law and Avogadro Hypothesis, and the conclusions to be drawn from it, in an excellent manner and the method of determining atomic weights of elements that are constituents of gaseous compounds is given as well as the method of finding molecular weights. The remainder of the book treats of food and clothing, fuels and electrochemistry.

Pupils who have had the course of five books under competent teachers should have acquired a rather good idea of what science is about and how it concerns them in their lives. A considerable number of directions for the performance of simple experiments accompanies the text and while brief they are excellent.

FRANK B. WADE

Atomic Artillery, by John Kellock Robertson, Professor of Physics, Queen's University, Kingston, Canada. Cloth. Pages xiv + 177. 13 × 20.5 cm. 1937. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price \$2.25.

The chief topic for research in physical science in recent years is the attack on the structure of matter. Students at all levels and people in all walks of life want to know what is known about the inside of an atom and how it was discovered. Writers have found it difficult to report the results of research because readers lack the necessary background. Professor Robertson has surmounted this difficulty by a happy choice of essential facts and simple language. He has succeeded in describing the experiments of Thompson and Millikan that isolated and measured the electron; the determination of atomic numbers by Moseley; the separation of the isotopes of the elements by the mass-spectrographs of Aston, Demster, and Bainbridge; the use of heavy atomic artillery through the studies of Rutherford in the field of radioactivity, by the Van de Graaff electrostatic high voltage generator, and by Lawrence's cyclotron. He has told the story of the discovery of the positron, the neutron, the deuteron, and their uses in breaking down elements and building up others. All this is accomplished by the use of non-technical language, illuminated by illustrations and analogies the layman can understand. The book is worth many times its cost, and no library of popular science is complete without it.

G. W. W.

The Universe Surveyed, by Harold Richards, Cloth. Pages xvii + 721. 14.5 × 22.5 cm. 1937. D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, N. Y.

It is vain to attempt in a brief review to tell much of the subject matter covered in a text of this type. It is our opinion that no text has appeared in this field which has a better selection of content than this one. But that is not the major virtue of the book. The author has truly sensed the pur-

pose of a survey course in physical science. He aims not to impart just so much information, but to lead his pupils to think as great scientists think. He makes no attempt to give a full year course in each of the four branches of physical science. He does not just fill page after page with disconnected and unrelated facts which seem to have no relation to the reader or to his experiences; on the contrary he selects a few fundamental discoveries and principles and takes time to lead the student through the steps in the discovery and to explain to him the significance of the results of the research. He states a few of the fundamental laws, explains them, and shows their significance. The history of the progress of science receives major consideration. The relation of scientific development to progress in religious thought, government and commercial expansion is stressed. Quantitative discussions are given where numerical relations help to clarify the topic, but mathematical analysis is never used. The author has written two chapters on energy and energy changes without the use of a single mathematical equation! But this is the plan of the book; it is written for the student who has not made the mathematical preparation for an analytical course in science. Such students will find the book an answer to many questions they have heard but thought beyond their comprehension. To them it opens a new library for enjoyment, relaxation, intellectual expansion, and possibly for future serious study.

G. W. W.

Both Sides of the Microphone, by John S. Hayes, and Horace J. Gardner. Cloth. 180 pages, 13×19 cm. 1938. J. B. Lippincott Company, 227 S. Sixth Street, Philadelphia, Pa. Price \$1.25.

This book may serve either of two purposes: (1) it gives valuable information regarding all types of work connected with radio broadcasting, and the general and special qualifications required for each type of work; (2) it presents an interesting account of the activities of all executives, technicians, artists, and employees engaged in putting on broadcast programs of all types, thus giving the radio audience a greater appreciation of the vast radio industry. The first of these purposes is vocational, the second is cultural. The book is in two sections: the first gives accurate information regarding the broadcasting station and its various departments such as programs, sales, publicity, engineering and executive. This section is scientific and dependable. There is no conjecture or mere opinion on values and results in this part. The authors know what they are talking about. The second part consists of a number of short essays from prominent personages before the mike; a news commentator, a dance orchestra leader, a special event announcer, a director of educational programs, etc. This section consists largely of opinions based, no doubt to a more or less degree, on fan mail and other similar sources of questionable reliability. Objective evidence in support of the opinions given is not presented, thus throwing the book completely out of balance. The book closes with a list of the names, power, location, and owners of all the North American Broadcasting Stations, listed by states or countries. The power column is erroneously listed as frequency in kilocycles instead of power in watts.

G. W. W.

Mechanical Properties of Matter, by S. G. Starling, B.Sc., A.R.C.Sc., F. Inst. P. Cloth. Pages vii+336. 12.5×20 cm. 1935. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$2.10.

This is a textbook of college grade designed especially to prepare students for Higher School Certificates. It covers the usual topics in a course in mechanics for general physics students, making use of the calculus

throughout. The theory is illustrated by complete solutions of many problems. Extensive lists of problems follow each chapter.

G. W. W.

Carl Friedrich Gauss. Inaugural Lecture on Astronomy and Papers on the Foundations of Mathematics, translated and edited by G. Waldo Dunnington. Cloth. Pages xi+91. 12.5×19 cm. 1937. Louisiana State University Press, Baton Rouge, Louisiana. Price \$1.00.

Students of physical science and mathematics will be interested in the brief biographical sketch of the early life of one of the very great thinkers of all time. The data were obtained not only from extensive study of the original books and notes in the Gauss Archive but also from descendants of Gauss now living in America. The latter part of the volume is made up of two little known papers by Gauss. They are "The Foundations of Mathematics" and the "Inaugural Lecture on Astronomy."

G. W. W.

REGARDING A STUDY OF THE SCIENCES FOR GENERAL COLLEGE EDUCATION

During recent years studies have been made of the contents, methods, and results of certain sciences used as part of college education. These studies, which were limited to special science subjects, made it clear that there is needed a comprehensive investigation which shall include all the major sciences used for general education.

During the meetings of the A.A.A.S. at Indianapolis, December 27, 1937, to January 1, 1938, the Executive Committee and Council passed the following resolution: "The Council voted to direct its standing Committee on the Place of Science in Education to represent the Association in the organization of plans for the evaluation and improvement of the teaching of science in colleges."

A committee that is representative of the sciences now offered in the colleges as a part of general education, is to be organized. The individual members will be selected from among those college teachers who are known for their scientific achievements and for their interest in improving teaching. Tentatively, the Committee is known as the Committee on Improvement of Science in General Education.

The work suggested to the Committee on Improvement of Science in General Education is roughly outlined in the following sections of this memorandum. It is understood that this Committee, when organized, shall further define its purposes and procedures, and shall be responsible for the supervision and conduct of its work. Constructive suggestions are welcomed from any source.

PROPOSED FUNCTIONS OF THE COMMITTEE ON IMPROVEMENT OF SCIENCE IN GENERAL EDUCATION

General: To initiate, encourage, guide, and support studies designed to explore, evaluate, and improve the teaching of the sciences as a part of general education.

Specific: 1. To clarify and define the problems involved in teaching the sciences as a part of the program of general education.

2. To develop a more scientific attack upon problems of science teaching: that is, to promote experimentation; to collect evidence, to encourage the use of procedures justified on the basis of organized and evaluated evidence in contrast to opinions, untested assumptions, and uncritical acceptance of traditional practices.

3. To disseminate information about the Committee's work, and to secure constructive criticism by means of discussion groups in college and university centers, by participation in programs, and by such other means as may be found effective.

4. To obtain and to use financial support for such work in the sciences as gives promise of being effective in improving the teaching of science in general education.

5. To serve as a clearing house for coordinating the activities of the several agencies now working on parts of the whole problem, and new agencies which may be initiated for the improvement of science teaching.

6. To act in an advisory capacity on any studies approved by it and supported through it; to require and coordinate reports of such studies; and to provide for publication of the findings.

Meetings of available members of the Committee on the Place of Science in Education were held in Indianapolis on December 30 and 31, 1937. A third meeting was held in Washington, D. C., February 20, 1938. Also, correspondence between committee members has helped to formulate this memorandum. The following statements as guides have been formulated:

1. The Committee on Improvement of Science in General Education should include outstanding scientists and college teachers who have a deep interest in general education, who have had successful experience with science at various levels, and who are able and willing to devote considerable thought and effort to the project.

2. The Committee on the Place of Science in Education should undertake to learn who are regarded as probably useful members of the proposed new committee. The Committee on Improvement of Science in General Education in its early stages should not be large, and may add to its own membership as it finds desirable, and as approved by the Executive Committee of the AAAS.

3. It is proposed that the Committee on the Place of Science in Education shall attempt to secure funds to support the preliminary meetings of the Committee on Improvement of Science in General Education, to employ a worker to serve under guidance by the Committee, and to cover the cost of exploring the project in order to formulate a comprehensive statement of the problems which should be attacked.

4. It is expected that the Committee on Improvement of Science in General Education will prepare its plans, and will request additional adequate funds for conduct of its work over a sufficient period of time to provide fundamentally significant results. Any funds granted for the work of the Committee shall be disbursed by the Permanent Secretary of the AAAS on orders issued and signed by the proper officer of the Committee on Improvement of Science in General Education.

5. It is the intention that, at the beginning, two persons will be named from each of the subject divisions. As soon as funds are available for the initial work of the proposed committee, the Committee on Place of Science in Education will proceed to enlistment of the initial members of the proposed Committee on Improvement of Science in General Education. These members will be asked to hold a meeting for organization and planning. Part or all of the members of the Committee on Place of Science in Education will attend the first session of the first meeting of the Committee on Improvement of Science in General Education. Thereafter the new Committee will proceed according to its own plans.

**COMMITTEE ON THE PLACE OF SCIENCE IN EDUCATION
OF THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE**

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Ralph Tyler, Ohio State University, Columbus, Ohio.

MOTION PICTURE TAKES MAN APART

A sound motion picture has just been released, for school use, which demonstrates the relationship of the parts of the human body and explains the function of the various organs and structures. This is accomplished by dissecting and demonstrating an anatomical model on the screen. This demonstration, with the accompanying explanatory narration, was prepared by Dr. Leslie Brainerd Arey, Professor of Anatomy in Northwestern University Medical School.

The film has been designed to be of help to teachers, students, and workers in the fields of health, biology, physiology and physical education. Title of the picture is "Anatomical Models, Their Production in America and Their Value in Visual Instruction." It was produced by the Atlas Educational Film Company, Chicago, Illinois, pioneer producers of educational motion pictures.

The film has been designed for use in high school and junior college classes, and for showings before section meetings at state and district teacher conventions. It is of particular interest to teachers and students because it not only demonstrates the organization and structure of the human body, but it also shows how anatomical models are designed and constructed. Seeing the film will give teachers a clearer conception of the teaching aids available in this type of visual instruction. It will also present to students information of definite instructional value.

**"TREASURE MOUNTAIN," SHOWING MINING ACTIVITY,
TO BE BUILT FOR SAN FRANCISCO FAIR**

Construction of "Treasure Mountain," a miniature mountain in whose interior visitors next year will have an opportunity to watch actual mining operations, will begin immediately at the Golden Gate International Exposition site on Treasure Island, San Francisco.

Housed in the recently-completed "Hall of Mineral Empire," whose entrance will resemble a mine tunnel, "Treasure Mountain" will duplicate a mountain range. Forced perspective, color and lighting will give peaks that rise fifty feet from the floor the illusion of great and distance. Spectators will stand in a central "valley" among the mountains, and will look at open cut copper mines of Utah, Arizona, and Colorado, mines in the Mother Lode Country, the Mataubi range works and others. Machinery will actually operate. The old assay office at Ophir, Calif., the first mint to be established in the gold country, will also be reproduced.

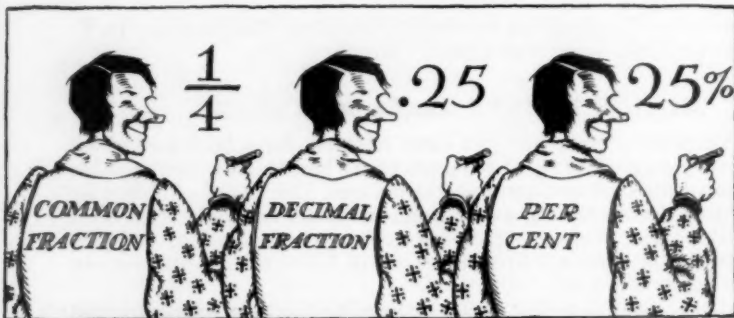
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